FERTILITY, POPULATION, AND THE ECONOMY: THE MACRO-IMPLICATIONS OF ALTERNATIVE LIFE CYCLE CHOICES

Frank T. Denton and Byron G. Spencer

McMaster University

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1. INTRODUCTION

The demographic history of Canada in the past half-century has been dominated by huge swings in fertility levels. The "baby boom" of the 1940s and 1950s was followed by the "baby bust" of the 1960s and 1970s, and then the continuing low levels of fertility of the 1980s. Immigration has of course been a significant factor in determining the rate of population growth and falling mortality rates have raised life expectancies by many years. Nevertheless, fertility change has been the dominant demographic influence over several decades and the major determinant of the present age structure of the population. Current concerns about "population aging" and its economic consequences are a legacy of the "boom and bust" sequence.

National average fertility rates are for the most part the collective outcome of conscious individual decisions. A proportion of births are unplanned but it is apparent that family size is largely a matter of choice in contemporary society. Moreover, decisions about numbers of children are closely linked to other household decisions. Children require time-consuming care and a share of household expenditure. The decision to have a child therefore implies less time in leisure activities, less time in income-earning activities and hence a reduced adult standard of living (as conventionally measured), or both. Implicitly or explicitly, decisions about family size are also decisions about labour force parti-

cipation, income, saving, and consumption, and in the aggregate (implicitly) about national production, investment, and capital accumulation. Microeconomic fertility choices have far-reaching implications for the macroeconomy.

The effects on the macroeconomy also extend far into the future. The baby boom caused an immediate sharp increase in the child population and the demand for child-related consumption goods. A few years later it increased school enrolment to unprecedented levels. Later still it increased the numbers of young adults looking for jobs, the rates of household formation, and the numbers of women in the childbearing ages. Eventually it will increase sharply the numbers of elderly people in the population. The baby bust, on the other hand, has had, is having, and will have consequences opposite to these. And there are also echo effects: the changing numbers of women in the childbearing ages cause fluctuations in numbers of births from generation to generation, and these fluctuations die out only slowly with the passage of time. Many hundreds of years may be required before they are no longer discernible, and there are effects of similar duration on the rates of household formation, the labour force, and the stock of productive capital. The consequences of the household decisions underlying the baby-boom-baby-bust sequence will be with us (and our descendants) for a very long time.

Some of the effects of fertility change are obvious -- the effects on school enrolment, and later the effects on rates of labour force entry of young people, for example. But some are not. Our aim in this paper is to explore a wide range of effects associated with fertility change. The tool that we use is a theoreti-

cal model of an economic-demographic macrosystem, adapted for computer simulation. The model is not a model of Canada; we emphasize that at the beginning. But we have specified the values of the parameters of the model in such a way that it has some of the major features of the Canadian situation. We hope therefore that the results of the simulation experiments that we report will throw light on how fertility change has affected the Canadian population and economy, at least in broad terms, and the implications of such change for the future. We have created an artificial "laboratory," so to speak, in which changes in fertility can be induced "experimentally" and the effects on the macrosystem obvserved.

The macromodel has its foundation in microeconomic life cycle theory. Life cycle theory (as economists use the term) is particularly appropriate, given the obvious importance of family size to patterns of consumption, saving, labour force participation, and other aspects of household behaviour. In essence, life cycle theory assumes that a household takes account of its lifetime stream of income and decides how to allocate that income to expenditures in different periods of its existence, borrowing against future income in some periods, saving for the future or consuming out of past savings in others. In our application of this basic idea the household makes a joint decision about how it will allocate its potential income stream among children, consumption, and leisure. Household decisions, taken collectively, affect the macroeconomy, including wage rates and the implicit or "shadow" prices of children and leisure. These aggregate price effects feed back on individual households, causing new decisions to be made at the microlevel.

There is thus a continuing series of interactions between households and the macroeconomy. The nature of these interactions is spelled out in detail below.[1]

The plan of the paper is as follows. We discuss the concept of family size as a life cycle decision in section 2, and in particular the trade-offs with consumption and leisure that are involved. We then discuss briefly the collective implications of microeconomic life cycle decisions for the macrosystem -- for the population in section 3, and the macroeconomy in section 4. A formal micromodel of household life cycle choice is developed in section 5. A macromodel is then developed, with the micromodel at its base; the macromodel is discussed in general terms in section 6, and in detail in section 7. At this point the stage is set for a series of simulation experiments.

The first set of simulation experiments -- ten in number -- is designed to illustrate how changes in household preferences for children, consumption, and leisure can affect the population and the macroeconomy in steady state (i.e., after all effects have had time to work themselves out fully); these experiments are reported in section 8. An experiment is then presented, in section 9, in which the time path of the baby-boom-baby-bust sequence is simulated by finding a time path of individual household preferences that comes close to producing the actual historical path of the national total fertility rate over the period 1936-86. Following this, we ask the question, "What if the history of fertility had been different?" and present a series of three "counterfactual" simulations; in particular we simulate the state of the population and economy as it would have been (according to our model) (a) if there had been no

baby boom or bust, (b) if the baby boom had continued (rather than ending at the beginning of the 1960s), and (c) if the fertility decline in the 1960s and thereafter had been "moderate," rather than as rapid and pronounced as it actually was. These "counterfactual historical" simulations are presented in section 10. In section 11 we look ahead half a century and use the macromodel to trace out alternative futures, under alternative assumptions about the future course of household children-leisure-consumption preferences. The paper concludes in section 12 with a summary statement of the project and its findings.

2. FAMILY SIZE AS A LIFE CYCLE TRADE-OFF DECISION

Suppose a young couple at the beginning of married life. They have a current earning capacity but little or no initial wealth. Looking to the future, they can anticipate a stream of earnings and other income over the course of their lives, and some day perhaps an inheritance. Whether explicitly or (much more likely) implicitly, they can think of the present value of future income as their lifetime wealth and about how they should allocate it. In particular, they can think about how many children they would like to have, about how much of their time they would like to devote to "leisure" activities, either during their working lives or in retirement, and about their "standard of living," as measured conventionally by their levels of consumption of goods and services at different ages. If they choose to spend more of their lifetime wealth in the earlier years -- because they have more children, for example -- they may borrow against future income, insofar as the providers of credit will permit. (They may take a mortgage loan to

finance the purchase of a house, for example.) Or they may plan for early retirement and save out of current income to make that possible. They may also save as protection against unforeseeable future events or in order to leave something for their children when they die. In short, they allocate their lifetime wealth to different uses and different periods of their lives; they are not restricted to spending only what they receive as income in any given year, although that is of course an option. But whatever they wish to do they are constrained by their level of lifetime wealth. Their problem is thus the classical problem of economics: the allocation of scarce resources (lifetime wealth) among competing uses (children, leisure, consumption, and contingencies or bequests).

Each use has a price associated with it, defined in terms of opportunities foregone -- an implicit or "shadow" price. Taking consumption as the standard, the price of leisure is the amount of consumption foregone by not working, as represented by the (after-tax) wage rate. The price of a child is the amount of consumption allocated to the child (and therefore foregone by the parents), plus the value of the time spent in looking after the child (and therefore not available for income-earning or leisure activities). The value of a unit of bequest or continency saving is the amount of foregone consumption (or equivalently, of foregone children or leisure). Choices are made (as always implicitly, if not explicitly) in light of the prices or trade-off costs associated with different uses of lifetime wealth -- and as the prices change (because of changes in wage rates, for example), so may the choices made by individual households.

Decisions about family size are thus also decisions about

leisure and consumption. They involve trade-offs in the allocation of lifetime wealth, and these trade-offs are made against a background of implicit prices or opportunity costs. Demographic choice is inextricably linked with economic choice at the microlevel. The collective effects of similar decisions by different households imply an inextricable linkage at the macrolevel as well.

3. IMPLICATIONS FOR THE POPULATION

The implications for the population are quite clear. If households share a common set of preferences for children this will be reflected in measured fertility rates, birth rates, and other demographic statistics. A shift in preferences towards having more children will cause an increase in the numbers and proportions of people in the youngest age groups. If the new preferences are temporary, a population "bulge" will be observed making its way along the age stream, eventually reaching the oldest age groups, and then disappearing. In addition there will be echo effects, as noted previously, and these will be transmitted from generation to generation for perhaps many hundreds of years. If, on the other hand, the new set of preferences is maintained, the population will eventually reach a steady state with an age distribution tilted toward the younger end. A shift in preferences away from children, such as to reduce fertility levels, will have opposite effects. In any event, immigration and mortality changes aside, the age distribution of the population at any given time is a clear reflection of the history of fertility. Nowhere is this more evident than in the present-day distribution of the Canadian population.

4. IMPLICATIONS FOR THE ECONOMY

The implications of household choices for the macroeconomy are more complicated. The effects of fertility changes on the subsequent demand for educational facilities are obvious, of course, and the later effects on the numbers of young people entering the work force are also rather obvious, although the timing of labour force entry can be altered by changes in educational enrolment rates. Less obvious are the effects of changes in fertility on the work patterns of women in the childbearing and child-raising ages. Children have immediate requirements for adult care and a share of household consumption goods; the trade-offs in this respect at the individual household level have their counterparts at the macro-level in changes in female, and perhaps also male labour force participation rates.

The effects of fertility on the size and rate of growth of the national work force are translated into effects on the attainable level of national production, and hence effects on income, saving, consumption, investment, government revenues and expenditures, wage rates, the growth of the capital stock, and virtually every other facet of the macroeconomy. The distribution of aggregate income among different age groups is affected. Changes in the population age distribution alter the patterns of intergenerational transfers of wealth through inheritance. The durability of the stock of capital implies that today's investment effects will be felt far into the future, adding a set of secondary dynamic economic influences to the primary demographic dynamics. The trade-off decisions made by households today thus set in train a sequence of future events that can alter drastically the time path of the econo-

my. And as the economy changes at the macrolevel there are feedback effects on future household decisions (through the influence of higher or lower wage rates and interest rates in particular) and new rounds of micro-macro interactions ensue. The economic implications of household decisions about how many children to bring into the world are thus profound, pervasive, and persistent.

5. A FORMAL MICROMODEL OF LIFE CYCLE CHOICE

We proceed now to the development of the micromodel on which the subsequent macromodel is based. As with all economic models we make some stringent assumptions, ignoring some aspects of economic reality in order to focus on others. (To quote an oft-quoted observation by Theil (1971,p.vi), "models are to be used but not to be believed.") Both the micromodel and the macromodel are similar in structure to ones used in earlier studies (Denton and Spencer, 1983,1984,1988).

We assume a population that forms itself into husband-wife households at the age of 18. (The average age of marriage, is of course, older than that. However, the choice of 18 gets us out of some practical difficulties that would otherwise arise later in the specification of the macromodel, and does no harm in what follows. The point of the assumption is that people's attitudes are formed in large measure when they are young. The average age of wives is somewhat lower than that of husbands, but we ignore that too.) An individual household in the model belongs to a cohort of identical households, the total number in the cohort being assumed very large. Each newly created household must make a lifetime plan.

Let r be the annual real rate of interest and τ a proportional

tax rate that is levied on all income. Let w_{ij} be the wage rate for a person of age j and sex i. (i=1 for male, 2 for female), and let u_{ij} and h_{ij} be the rate of unemployment and the value of inheritance received, respectively, for such a person. Taking account of taxes and unemployment, the effective rate of return to labour force participation is $w'_{ij} = (1-\tau)(1-u_{ij})w_{ij}$ and the effective rate of return on actual or realized wealth is $r' = r(1-\tau)$. A couple plans to live until age J. Letting $\bar{p}_{ij}$ be the maximum possible labour force participation rate (proportion of time worked), the couple calculates its present-value potential wealth as

$$(1) \quad V = \sum_{j=18}^{J} (1+r')^{18-j} \sum_{i=1}^{2} (\bar{p}_{ij} w'_{ij} + h_{ij})$$

It then allocates its potential wealth among five categories: lifetime consumption (V_0), lifetime leisure of the husband and wife (V_1 and V_2), children (V_3), and an allowance for bequests and contingencies (V_4). Thus $V = V_0 + V_1 + V_2 + V_3 + V_4$. We require $V_s/V > 0$ (s=0,1,2,3,4).

The component V_0 is the present value of consumption of the husband and wife. Their consumption is planned to be the same at every age (in real terms) and they share equally in it. Planned annual consumption per adult is C^* and V_0 is then given by

$$(2) \quad V_0 = \pi_0 C^*; \quad \pi_0 = 2 \sum_{j=18}^{J} (1+r')^{18-j}$$

π_0 can be interpreted as the shadow price associated with C^*; it is seen to be a function of the after-tax rate of return on wealth and the expected length of life.

Planned leisure is denoted by R_{ij}, the fraction of time not worked by a person of age j and sex i (the fraction of maximum possible annual labour force participation time, that is). To make manageable what would otherwise be a quite difficult optimization problem we assume that a household chooses total lifetime leisure for the husband and for the wife, and then allocates each total by age according to a fixed rule. If R_i is total lifetime leisure for sex i, the rule is $R_{ij} = b_{ij}R_i$, where b_{ij} is an age-sex-specific constant. V_1 and V_2, the present values of the husband's and wife's lifetime leisure, are then calculated as

$$(3) \quad V_i = \pi_i R_i; \quad \pi_i \doteq \sum_{j=18}^{J} (1+r')^{18-j} b_{ij} w'_{ij} \qquad (i=1,2)$$

The shadow prices of lifetime leisure, π_1 and π_2, are thus functions of wage rates, adjusted for tax and unemployment, the after-tax rate of return on wealth, the age allocation constants, and the expected length of life.

The costs of raising a child are of two kinds. One is related to the amount of time spent in caring for the child, and hence not available for paid work. Assuming, for purposes of the model, that all child care in the home is provided by the wife, this cost is $c_k w'_{2j}$ when the child is of age k and the wife of age j, c_k being the annual amount of care time required by a k-year-old. The other kind of cost is related to the amount of consumption allocated to the child. We assume that if consumption per adult is C^*, then consumption by a child of age k will be $a_k C^*$, $0<a_k<1$. (The proportionality of child and adult consumption can be interpreted as a social norm.)

The total annual cost of a child of age k with a mother of age j is thus $c_k w'_{2j} + a_k C^*$ and the aggregate annual cost for all children in a household is found by summing over all children present. Ignoring child mortality and the possibility of adoption, the number and age distribution of children at any given time are functions of the household's fertility history. The age distribution of mothers at childbirth is taken to be fixed in the model, so that for an average household within a cohort we may write $f_j = \varphi_j F$, where f_j is the age-specific fertility rate at age j, F is the cohort total fertility rate over its childbearing range, and φ_j is the proportion of total fertility that occurs at age j. An average couple then calculates V_3 as the present value of all of the children that it plans to have:

$$(4) \quad V_3 = \pi_3 F; \qquad \pi_3 = \sum_{j=18}^{J} (1+r')^{18-j} \sum_{k=0}^{17} \varphi_{j-k} (c_k w'_{2j} + a_k C^*)$$

The shadow price of children, π_3, is seen to be a function of women's wage rates, child care time requirements, the adult consumption level and the relative consumption requirements of children, the age distribution of fertility, the after-tax rate of return on wealth, and the expected length of life.

The final component of present-value lifetime wealth is the bequest-contingency allowance, V_4. This can be determined either residually or as follows:

$$(5) \quad V_4 = \pi_4 Z; \qquad \pi_4 = (1+r')^{18-J}$$

where Z is the amount of real wealth to be available at the terminal age J if the life course of the household accords with its

original plan. (Z is measured in the same units as consumption.) The shadow price of Z depends only on the expected length of life and the after-tax rate of return on wealth. We note, for subsequent purposes, that the ratio of the accumulated bequest-contingency allowance to the level of adult consumption when the husband and wife are of age j is given by $v_j = (V_4/C^*)(1+r')^{j-18}$.

The planned allocation of lifetime wealth among the five component categories may be thought of as the result of maximizing a lifetime utility function. The arguments in the utility function are C^*, R_1, R_2, F, and Z. The function is maximized subject to the wealth constraint $V = V_0 + V_1 + V_2 + V_3 + V_4$. We assume the function to be of the Stone-Geary type. Utility (U) is then given by

$$(6) \quad U = (C^*-\bar{C})^{\gamma_0}(R_1-\bar{R}_1)^{\gamma_1}(R_2-\bar{R}_2)^{\gamma_2}(F-\bar{F})^{\gamma_3}(Z-\bar{Z})^{\gamma_4}$$

where the parameters γ_s (s=0,1,2,3,4) are nonnegative and sum to one. (The nonnegativity requirement implies positive marginal utility for each argument. The unit sum requirement can be viewed as the result of applying a normalization rule since any monotonic transformation of the function would serve just as well as the one specified.) $\bar{C}$, $\bar{R}_1$, $\bar{R}_2$, $\bar{F}$, and $\bar{Z}$ are the Stone-Geary minimum required levels of the five utility-producing variables.

We assume that every household within a cohort is the same as every other household. This being the case, all households will end up with the same set of values for C^*, R_1, R_2, F, and Z. We assume also that the minimum required levels are determined by social norms: if the average values (which are also the values for

each household) of C^*, R_1, R_2, F, and Z change through time, notions about "minimum requirements" will change also. Specifically, we assume a set of proportionality relations and write

$$(7) \quad \bar{C} = \lambda_0 C^*; \quad \bar{R}_1 = \lambda_1 R_1; \quad \bar{R}_2 = \lambda_2 R_2; \quad \bar{F} = \lambda_3 F; \quad \bar{Z} = \lambda_4 Z.$$

Substituting (7) into (6) and rearranging terms allows the utility function to be rewritten as

$$(8) \quad U = \Lambda (C^*)^{\gamma_0} (R_1)^{\gamma_1} (R_2)^{\gamma_2} (F)^{\gamma_3} (Z)^{\gamma_4}$$

where $\Lambda = \pi_s (1-\gamma_s)^{\gamma_s}$ serves simply as a scaling constant. The proportionality assumptions thus convert the Stone-Geary utility function into a Cobb-Douglas form. This is a convenient result from the point of view of the macromodel developed later to be used for long-run simulations since it makes little sense to assume that society's notions about "minimum requirements" are unchanged over long periods of time.

The utility function can be modified further. Letting $P_s = V_s/V$ (s=0,1,2,3,4) we can write

$$(9) \quad U = (\Lambda \Gamma) \prod_{s=0}^{4} (P_s)^{\gamma_s}$$

where $\Gamma = V \Big/ \prod_{s=0}^{4} (\pi_s)^{\gamma_s}$. The π values are exogenous from the point of view of an individual household. The household's optimization problem is then equivalent to the problem of finding a vector $P = [P_0\ P_1\ P_2\ P_3\ P_4]$ that maximizes the function in equation (9) subject to the restriction that the elements of P must sum to one. The solution to this problem is seen to be $P = P^*$, where $P^* = [\gamma_0\ \gamma_1$

$\gamma_2\ \gamma_3\ \gamma_4]$. Elsewhere (Denton and Spencer, 1983) we have referred to P as a life style, and to P^* as the household's optimium life style. The optimum life style is thus one in which the household allocates its total lifetime wealth among the five categories in the proportions γ_s (s=0,1,2,3,4). These proportions may be referred to as taste parameters. A change in the set of taste parameters implies a change in the optimum life style, and therefore different allocations of wealth among consumption, leisure, fertility, and the bequest-contingency allowance.

The labour force participation of the husband and wife are determined by the choices of leisure and fertility levels. In the case of males, the annual participation rate at a given age j is the difference between the maximum possible rate at that age ($\bar{p}_{1j}$) and the proportion of time spent in leisure (R_{1j}):

$$(10)\quad p_{1j} = \bar{p}_{1j} - R_{1j} = \bar{p}_{1j} - b_{1j}R_1 \qquad (j \geq 18)$$

In the case of females, annual time spent in child care must also be subtracted:

$$(11)\quad p_{2j} = \bar{p}_{2j} - b_{2j}R_2 - \sum_{k=0}^{17} \varphi_{j-k}c_k \qquad (j \geq 18)$$

Total household consumption, C^{**}, is the sum of the husband's and wife's consumption (each of which is C^*) and the children's consumption. Under the previous assumptions that a child of age k consumes a_kC^* and that the number of children born to a couple of age j is $f_j = \varphi_jF$, total household consumption is given by

$$(12)\quad C_j^{**} = \left(2+F\sum_{k=0}^{17}\varphi_{j-k}a_k\right)C^*$$

Note that here and in other relations involving fertility there is no restriction forcing the number of children to be an integer. (A family with 2 1/2 children is quite possible!) The relations obviously must be interpreted as applying to an average household. Requiring the number of children to be an integer would complicate the micromodel considerably, and subsequently in the macromodel would yield unrealistic cohort total fertility rates.

Given all parameters of the system and all exogenous variables (wage, interest, and tax rates, among others), it is a straightforward matter to solve for the choice variables. Equation (1) determines V and its five components are calculated from $V_s = y_s V$ (s=0,1,2,3,4). The optimizing values of C^*, R_1, R_2, F, and Z are then obtained from equations (2), (3), and (4). Labour force participation rates and total household consumption can be obtained from (10), (11), and (12).

The making of a lifetime plan implies expectations about the future -- about future wage rates, rates of taxation, interest rates, and amounts and timing of inheritances. We assume that the household expects current wage, tax, and interest rates to be maintained over its life course. (By "current" we mean the most recently observed rates, which in practice are those of the immediately preceding year.) In the case of inheritances, we assume that expectations are based on averages over the previous fifty years. Further observations on the role of expectations in a life cycle model and some results from earlier experiments are reported

in Denton and Spencer (1983). The bequest-inheritance mechanism in the model for transferring wealth from (generally) older cohorts to (generally) younger cohorts is defined more precisely below in specifying the macromodel.

The household's expectations may (and generally will) turn out to be in error as the future unfolds. In the real world new information is continuously being processed, expectations revised, and plans modified accordingly. To simplify matters somewhat for the model we require that the household stick to its initial plan with regard to fertility and leisure (and hence labour force participation). However, it is allowed to change its planned level of consumption to accommodate new information. In other words, it is allowed to choose a new optimizing value of C^* as it moves through time, conditional on F, R_1, and R_2 remaining at their originally chosen levels.

One bit of new information available each year to the household is that the husband and wife have survived another year, and that their life expectancy has therefore changed. At age $j'>18$, the terminal age for planning purposes is now $J'>J$. The household revises its consumption plan under the restriction that the present value of consumption over its remaining lifetime (the period from j' to J') must equal the present value of future income and inheritances, plus actual current wealth, minus the present value of the bequest-contingency allowance. For simplicity we assume that the v ratios remain as originally planned, so that at every age j' a revision of C^* induces an equivalent proportionate revision of Z. From equation (5) and the subsequent definition of the v ratios, $Z = v_j C^*(1+r')^{J-j}$. Z responds to changes in r' as

well as C^*, but those changes are exogenous to the household decision-making process. The present value of Z at age j' is equal to $v_{j'}C^*$.

Let W denote the realized (i.e., nonhuman) wealth of the household. We have assumed that initially the household had no realized wealth ($W_{18}=0$). However, at age $j'>18$ the household's realized wealth may be positive or (if it is in a debtor position) negative. As before, planned adult consumption is assumed to be the same at every future age. The revised annual level of C^*, as planned at age j', must therefore satisfy the equation

$$(13)\quad C^*\sum_{j=j'}^{J'}(1+r')^{j'-j}\left(2+F\sum_{k=0}^{17}\varphi_{j-k}a_k\right) = W_{j'}+\sum_{j=j'}^{J'}(1+r')^{j'-j}\sum_{i=1}^{2}(p_{ij}w'_{ij}+h_{ij})-v_{j'}C^*$$

where the values of r', w', and h are now based on the revised expectations held at j'. All variables in equation (13) are known except C^* and the latter can therefore be found easily from the equation.

6. GENERAL FEATURES OF THE MACROMODEL

The micromodel described in the previous section is the key behavioural component of the macromodel. In the present section we note the general features of the macromodel, including those that derive from household optimization decisions as well as others. The details of the macromodel are discussed in the next section.

The macromodel is designed for long-term computer simulations. It incorporates single-age detail for males and females separately. The time paths of individual cohorts of house-

holds are tracked year-by-year and the time paths of the overall population and economy, obtained by aggregation, are tracked also. A set of macrovariables summarizing the changing state of the economic-demographic system is generated and recorded as the system moves through time.

The macromodel is driven by its initial conditions and the optimizing and reoptimizing decisions of households. Household preferences for children, leisure, consumption, and bequest-inheritance allowances are defined by a utility function of the kind discussed previously. Labour force participation rates, fertility rates, rates of consumption and saving, wage rates, interest rates, investment, the capital stock, aggregate production and income, the age distribution of the population, and other variables all derive essentially from the household decision process. But the macrosystem also has feed-back effects on household decisions: as the state of the system changes, so too do expectations about the future, and hence the decisions that households in particular cohorts make about how to allocate their lifetime wealth.

The demographic relations at the macrolevel are essentially those of a standard population projection model. The population is closed: there is no immigration or emigration. The course of the population is thus determined entirely by the initial age distribution and the rates of mortality and fertility. Mortality rates are taken as fixed; fertility is thus the only endogenous element on the demographic side of the model.

On the economic side, the model is essentially neoclassical (as are most models with a long-run orientation). All of the

expenditure, income, and wealth variables are defined in real terms. Output is treated as if it were a single good that can be used for either consumption or investment. (Alternatively, one can think of output as consisting of different goods combined into a single aggregate at constant prices, in the manner of the constant-dollar national accounts.) The overall rate of unemployment is assumed to be continuously at its "natural" level (short-run or cyclical variations are not of interest in the present context) but unemployment rates are allowed to differ by age and sex, so that the effects of changes in the composition of the labour force can be taken into account. Different productivity weights are assigned to labour of different ages and sexes, and the total weighted labour input is nested, along with capital input, in an aggregate Cobb-Douglas production function. As a simplification, the model abstracts from technical progress; output is therefore determined entirely by the levels of the labour and capital inputs. The economy, like the population, is closed: there are no imports or exports. The disposition of the national product is therefore in three directions: to private consumption, to investment, and to government use. All capital formation is assumed to take place in the private sector; the government share of the product is for current use only.

7. DETAILS OF THE MACROMODEL

The equations of the macromodel are provided in an accompanying list, together with definitions of the symbols used. The equations are grouped into eight sectors. We discuss these sectors in the sequence in which they are listed.

Population

This sector consists of ten equations or sets of equations. Equation (1) is a summary way of expressing the fact that the total fertility rate of a cohort that is of age j in year t is determined as the solution of the household optimization problem when the cohort (men and women combined) is of age 18, as described in the earlier discussion of the micromodel. As indicated by the short-hand used in the equation, households choose an optimum level of total completed fertility (F), conditional on their expectations about future inheritances and wage, interest, and tax rates. Total fertility is then allocated by age of mother in fixed proportions over the age range 18 to 49, thus obtaining age-specific rates (f), as stated in equation (2). In practice there is some fertility at ages younger than 18 and that is allowed for in equation (3) by treating fertility at ages 15-17 in any year as proportional to the total fertility rate chosen by 18-year-olds in the same year. Equation (4) simply states that there is no fertility in the model at ages younger than 15 or older than 49.

The total number of births (B) in the twelve months preceding the midpoint of a given year is determined in equation (5) by applying age-specific fertility rates to the female population at each age over the childbearing range and summing. Fertility rates and populations are averaged over two consecutive years for each cohort in order to "centre" them, thus allowing for the fact that the cohort of mothers is, on average, half a year younger at the time of birth than it is at the midpoint of the current year. Births are then allocated between males and females in accordance

with a fixed sex ratio (s), as in equations (6).

The population (N) of each sex and age, from age 1 to 109, is obtained in equation (7) by applying age-sex specific mortality rates (d) to the population of the previous year and aging the survivors by one year. (As noted previously, the population is closed so there is no adjustment for migration.) The male and female populations under the age of 1 (i.e., j=0) are obtained, in equation (8), by applying mortality rates to the numbers of births in the preceding twelve months. The total population in each cohort, males and females combined, is determined in equation (9), and the overall total population in equation (10).

Labour Force and Employment

The rates of labour force participation (p) are an outcome of the household optimization decision, as expressed in equation (11). Rates for both sexes at all ages 18 and over are determined for each cohort at the time of its initial optimization decision, conditional on the expectations about future inheritances and wage, tax, and interest rates, the determination being as described in the previous discussion of the micromodel. For ages 15-17, the rates are assumed to be equal to those of the previous year, plus a fraction of the change in the 18-year-old rates, as represented by equation (12). This is simply a convenient device for keeping the younger teenage rates in line with those of older teenagers, given that the micromodel does not itself determine rates for ages less than 18, but that in practice there is participation below that age.

The labour force (L) of each age and sex is obtained by applying the participation rates to the population, as in equation

(13). Employment (L') is then calculated in (14) by applying age-sex-specific unemployment rates to the labour force. (As noted previously, the unemployment rates are assumed to be at "natural" levels, although these levels are set so that they vary among age-sex groups in accordance with observed historical Canadian patterns.) The total labour force and total employment are obtained in equations (15) and (16) by summation.

Production

The output of the economy (Q) is generated by an aggregate production function with constant returns to scale. Productivity weights (q) are assigned to the various age-sex categories of employment and "effective" labour input is calculated in equation (18) as the corresponding weighted sum. The effective labour input function (L^*) is then nested within the production function of equation (17), together with aggregate capital input. (Capital services are assumed proportional to the stock of capital, K, and the latter thus represents capital input in the production function.)

Income and Factor Returns

Both labour and capital are assumed to be paid at rates equivalent to their marginal products. In the case of labour this produces a set of age-sex specific wage rates (w) defined by equation (19) and an overall average wage rate defined by (20). The rate of return to capital (r) is defined, net of the rate of depreciation (δ), in equation (21). The net rate of return to capital is interpreted also as the rate of interest on borrowed funds in the model; thus both wage rates and the rate of return to

capital represent endogenously determined macrovariables that influence the optimization decisions of households at the microlevel.

Annual net before-tax income (Y) is calculated for each age group in equation (22); it is the sum of wage rates multiplied by numbers of persons employed, plus the net rate of return on the (nonhuman) wealth (W) held by the group. Net income before tax for the economy as a whole is obtained in equation (23) by summing over age groups.

Private Consumption and Savings

Annual consumption per household (C^{**}) for each age of husband and wife is determined by the household optimization process, with continuous reoptimization as cohorts of households move along their life paths. Expectations about future inheritances and wage, tax, and interest rates are continuously being revised in the light of the current state of the macroeconomy, and the optimization decisions are revised accordingly. All of this is represented by the short-hand notation used in equation (24).

Total consumption (C) for a cohort of age $j \geq 18$ in year t is calculated in equation (25) as the product of number of households of that age and average consumption per household. (The number of households in a cohort is equal to the population of the cohort divided by two, since all households are husband-wife units, with husband and wife of the same age.) Since in practice there is labour force participation by persons 15-17, provision for the disposition of the income of this group needs also to be made. (As with the fertility and labour force participation rates of 15-17-year-olds, this represents a necessary minor departure from the

theoretical micromodel.) It is assumed that all of the after-tax income of 15-17-year-olds is consumed, as stated in equation (26).

The annual net saving (S') of each household cohort is identically equal to net after-tax income, minus the household's consumption. This is expressed in equation (27). Economy-wide aggregates are obtained in equations (28)-(30): aggregate consumption in (28), aggregate net saving in (29), and aggregate gross saving in (30). Gross saving (S) is obtained by adding depreciation (δK) to net saving.

Wealth and Inheritance

A cohort's wealth at the beginning of any year is equal to its wealth at the beginning of the previous year, plus net saving during the previous year, plus the sum of inheritances (H) received from all cohorts in the population, minus bequests (transfers out of the cohort's wealth as a result of the deaths of some of its members). Equation (31) determines the wealth of cohorts 18 and over in this manner, while equation (32) states that the wealth of cohorts under 18 is zero. The bequests going out of a cohort's wealth are calculated in equation (33) as a fraction of what the wealth would have been before inheritance transfers, the fraction being equal to the cohort's ratio of deaths to population. For reasons discussed in Denton and Spencer (1983), all inheritances in a given year are pooled and the share of the pool going to a particular cohort is a fraction (ξ) that depends on the cohort's age, as seen in equation (31). Aggregate wealth in the economy as a whole is calculated in equation (34) by summing over cohorts of different ages.

Investment and Capital Stock

Annual gross investment (I) is identically equal to the annual total of gross saving in the economy, as stated in equation (35), and the stock of capital (K) is equal to total wealth, as stated in (36). The stock of capital, which is measured at the beginning of a year, is also equal to the undepreciated portion of last year's stock, plus last year's gross investment, as in (37). The stock of capital can thus be derived in two different ways. Equations (36) and (37) yield the same result and one of them may therefore be regarded as redundant for purposes of solving and simulating with the model.

Government Consumption and Taxes

This final sector of the model determines government consumption (G), taxes (T), and the overall tax rate (τ). The government is assumed to take a share of the national output for current use, but with a lag representing delayed response. (As noted previously, the government does not create capital in the model; all government expenditure is therefore regarded as consumption expenditure.) Annual government consumption is set equal to a weighted fraction of the national product in the preceding five years in equation (38). The budget is assumed always to be in balance and taxes are therefore set equal to government consumption, in equation (39). Taxes are levied on net income, and the tax rate is automatically determined by government consumption requirements, as stated in equation (40).

A Note on the Structure of the Model

The model, as just described, and as set forth in the list of equations, is highly interdependent in a dynamic sense. That is to say, it incorporates a number of fundamental feed-back loops — from household decisions about fertility, labour force participation, and private consumption, to wage rates, the interest rate, and other variables in the macroeconomy, and back to the household decision-making process in the form of altered expectations. However, from the point of view of a single year the model is entirely recursive. Given the previous year's values for all variables, the equations can be ordered in such a way that they can be solved sequentially. This simplifies and facilitates the carrying out of simulation experiments. Such a structure is appropriate for a model with a long-run orientation.

Parameter Values

In order to simulate with the model, values must be assigned to the model's parameters. In general terms, we have, where possible, assigned values on the basis of Canadian data. The model does not represent Canada, as we emphasized at the beginning of the paper. However, we wanted the experiments with it to yield at least broad conclusions of some relevance to the Canadian situation.

Many of the parameter values chosen are generally similar to those chosen in earlier experiments with models like the present one. We refer the reader to Denton and Spencer (1983) for details and provide here only a summary.

Parameters relating to the labour force are based on

Canadian Labour Force Survey data. These parameters include unemployment rates (u) and maximum labour force participation rates ($\bar{p}$). The latter are not, of course, directly observable but we have inferred them from observations of actual age-sex participation rates.

The fertility age distribution parameters (φ) are based on Canadian vital statistics and the mortality rates (d) are from Canadian life table sources. Age-productivity weights (q) are based roughly on census earnings data. Inheritance share parameters (ξ) are based on the assumption that inheritances peak at about the age of 50, rising linearly before that age and declining linearly thereafter. Adult equivalent consumption weights (a) rise from 0.25 at birth to 1.0 at age 18. The child care weights (c) start at about 0.3 in the first year of life (i.e., 3/10 of an adult year is required to care for a child under the age of 1); they then fall to 0.12 at age 6, and to 0 by age 15. The parameters representing the age distribution of lifetime leisure (b) are based on differences between actual and maximum labour force participation rates, in the case of males. For females, the actual participation rates are adjusted to allow for time spent in child care before calculating the differences from maximum rates.

The parameter of the production function representing the elasticity of output with respect to capital input (β) is set at 0.3, a value roughly consistent with the calculated share of the gross domestic product accruing to capital (before depreciation allowance) and with earlier econometric estimation by the authors. The scale parameter in the production function is set so that total output will be 100.0 in the first year of any experiment. The

annual rate of depreciation of the capital stock (δ) is set at 0.05.

The parameters representing the government's share of national output (θ) are set so that they sum to 0.2 (i.e., if the model system is in a stationary state the government absorbs 20 percent of output for current consumption purposes). The individual share parameters have a linearly declining lag structure over 5 years, starting with $\theta_1 = 5/75$ and ending with $\theta_5 = 1/75$.

The parameters of the household utility function -- the γ parameters -- are reset for each experiment. Indeed, the purpose of the experiments described below is to simulate the effects of different sets of γ values, or different patterns of change of these values over time. The γ parameters represent cohort preferences for children, leisure, and consumption, as reflected in different allocations of lifetime cohort wealth. By controlling the values assigned to the parameters the macro-effects of different patterns of household preferences can be studied.

8. EFFECTS OF HOUSEHOLD PREFERENCES ON THE STEADY STATE PROPERTIES OF THE MACROSYSTEM

We begin our examination of simulation results by considering a series of ten experiments designed to expose the very long-run macro-effects of alternative sets of household preferences. The γ parameters of the household utility function sum to unity and are equivalent to the proportions of lifetime cohort wealth allocated to consumption, male and female leisure, fertility, and bequests or contingency allowances. In this series of experiments we start with an initial specification of the γ parameters and then consider changes in them amounting, in each case, to

a transfer of 5 percent of lifetime wealth among selected categories. The nature of the experiments and the values assigned to the γ parameters are summarized, for convenience, in the Summary of Experiments statement.

We are concerned, in these first ten experiments, only with steady state results. To obtain these, we allow the model to run for seven or eight hundred years in simulated time with given γ values. (This length of time is generally sufficient for the model to achieve, to a very close approximation, a steady state, i.e., one in which rates of growth and other characteristics of the system are no longer changing.) The results are reported in Table 1. Each column of the table presents the results of a different experiment. The first three entries in a column are indexes of adult consumption per capita (C^*), male leisure (R_1), and female leisure (R_2), as determined by each cohort when the households within the cohort make their initial lifetime plan. The fourth entry is the cohort's planned fertility (F). The first four entries are thus the outcome of household optimization decisions. The remaining fifteen entries relate to the population as a whole or to the macroeconomy. Demographic variables include the total fertility rate (TFR), the crude birth rate (B/N), the percentages of population in the under-15 and 65-and-over age groups ($\%N_{0-14}$ and $\%N_{65+}$), and the rate of growth of the population (g(N)). The economic variables include rates of growth of the labour force (g(L)), of effective (productivity-weighted) labour input ($g(L^*)$), of output (g(Q)), and of the capital stock (g(K)). They also include the real rate of interest (r), the capital-output ratio (K/Q), indexes of output per unit of effective labour input (Q/L^*) and per member of the population (Q/N), the

gross savings rate (S/Q), and the net savings rate (S'/Q).

Benchmark Experiment

The first column of Table 1 reports results for Experiment 1, which may be viewed as a "benchmark" experiment. It assumes a set of γ parameters chosen so as to yield planned fertility of 2.1 children per woman (and also per household, given the assumptions of the model). Because the system is in steady state equilibrium, planned and actual fertility are the same. TFR is therefore also equal to 2.1, which is the total fertility rate required for a stationary population. Since the population is stationary, so too is the economy; all growth rates are therefore zero. The population is thus just replacing itself each year in Experiment 1 and the capital stock is just being maintained, as evidenced by a zero net savings rate. The real interest rate is 1.9 percent, the capital-output ratio 4.4, and the gross savings rate 21.9 percent.

Increased Preference for Children

Experiments 2, 3, and 4 assume an increased preference for children. Households shift 5 percent of their anticipated lifetime wealth into the fertility expenditure category and away from other categories. γ_3 thus rises from 0.1568 (the value required for a stationary population, as in Experiment 1) to 0.2068. The three experiments differ as to how the compensating reduction in the other categories is distributed.

The compensating adjustment is distributed among the consumption and leisure categories in Experiment 2: γ_0, γ_1, and γ_2

are all reduced proportionately from their Experiment 1 levels. For an individual household, the effect is to reduce C^*, R_1, and R_2, and to increase F. C^* is lowered by about 16 percent from the Experiment 1 level and R_1 and R_2 by lesser proportions. F rises to 2.8, and so consequently does TFR. The total fertility rate in the population is thus well above the natural replacement level, and in consequence the population grows at 1.1 percent per year. Since there is no technical progress in the system, all other aggregates grow also at 1.1 percent. (The equivalence of the growth rates is true for all of the steady state experiments of Table 1. The rates for the individual variables are nevertheless shown in order to have a standard tabular format; in subsequent tables, where time paths are shown rather than steady states, the rates will be seen to be different.) With a growing population the proportion of children rises sharply and the proportion of elderly people declines. The decreases in leisure time are associated with increases in labour force participation rates. Labour productivity (Q/L^*) falls by 4 percent and output per population member (Q/N) by 8.4 percent. (The labour force is younger, on average, and hence less experienced. Also, there is a larger proportion of the population in the dependent age groups.) Associated with the growing economy are a rise in the real rate of interest, a decline in the capital-output ratio, a positive <u>net</u> savings rate (4.2 percent of national output), and an increased <u>gross</u> savings rate. All of these changes from Experiment 1 to Experiment 2 are, it may be emphasized, a result of a shift of only 5 percent of household lifetime wealth into the raising of children. It is evident here, as in the subsequent experiments, that the transfer of a rather small proportion of

lifetime wealth can have very large effects on the character of the population and the economy.

Experiment 3 differs from Experiment 2 in that the transfer of lifetime wealth into the fertility category is offset entirely by a reduction in the consumption category; the shares going to leisure are unchanged. The final effect on planned adult consumption is almost the same as in Experiment 2, surprisingly enough; after all of the interactions between household decisions and the macroeconomy have worked themselves out, C^* is less than 2 percent below the Experiment 2 level, although it is a full 18 percent below the level of Experiment 1. The levels of the planned leisure indexes are higher than in Experiment 2, as expected. The total fertility rate is again 2.8, and the annual rate of growth 1.1 percent, as before. (The growth and fertility rates are not quite identical in Experiments 2 and 3, although the differences disappear after rounding. This explains why the age distribution percentages are a little different.) The macroeconomic variables are quite similar too.

Somewhat greater differences are produced in Experiment 4, in which the transfer of lifetime wealth to fertility is entirely at the expense of the leisure categories. The total fertility rate is 2.6 rather than 2.8 -- still well above the natural replacement level, but sufficient to produce an annual growth rate of only 0.8 percent, instead of 1.1. Household leisure is greatly reduced: the male and female leisure indexes are 79.2 and 72.4, with the Experiment 1 levels equal to base values of 100.0. In consequence, labour force participation rates are much higher. At

2.9 percent per annum, the real interest rate is somewhat higher than in Experiments 2 and 3, and markedly higher than in Experiment 1. (Indeed, the interest rate is higher in this experiment than in any other of the ones for which results are shown in Table 1.) The capital-output ratio is a little lower than in Experiments 2 and 3, and output per population member is higher (largely because of the higher proportion of people in the labour force). There is still a positive net rate of saving, although the rate is lower than in the previous two experiments.

To sum up the results of Experiments 2-4, what might appear to be a relatively small change in tastes -- a change that leads to a transfer of only 5 percent of lifetime wealth to fertility -- has a major long-run effect on the rate of growth of the economic-demographic system, the age distribution of the population, and the functioning of the economy. The rate of growth and rates of saving are greater if the increased preference for children is offset mainly by a compensating reduction of the proportion of lifetime wealth allocated to consumption than if the adjustment takes place in the leisure allocations; on the other hand, output per capita is greater if the reverse is true. But in any event, the economies produced by the altered preferences, and hence wealth allocations, differ markedly from the stationary economy of the benchmark case.

Increased Preference for Consumption

The next set of experiments, Experiments 5, 6, and 7, assumes an increased preference for consumption. Five percent of lifetime wealth is transferred into the consumption category and out

of other categories, again taking Experiment 1 as the "benchmark" or pre-transfer case. In Experiment 5, the transfer comes from both the leisure and the fertility categories, being distributed among them pro rata. In Experiment 6, the transfer comes entirely from the fertility category; in 7 it comes entirely from the two leisure categories, again being distributed between the two pro rata.

The reallocation of lifetime wealth in Experiment 5 induces a fall in the total fertility rate from 2.1, as in Experiment 1, to 1.7 (a rate that happens to be about the present level in Canada). The population is therefore no longer regenerating itself and the rate of growth is negative; the system is declining at 0.8 percent per year. The level of household consumption rises (C^* increases by 21.5 percent), in accordance with the shift in preferences, and the rate of saving in the system as a whole drops sharply. Indeed, with a declining capital stock, net saving is negative: the economy dissaves at an annual rate of 3.6 percent. The population age distribution shifts in the expected direction, the proportion under 15 falling and the proportion 65 and over rising. The increased preference for consumption has thus produced a declining economy and a declining and substantially older (on average) population.

If the increased preference for consumption is accommodated entirely by a decreased preference for children, as in Experiment 6, the results are, for the most part, qualitatively similar, but much more pronounced. The total fertility rate falls to 1.4; the population and the economy decline at 1.6 percent per annum; the age distribution shifts more markedly in the older direction; and the rate of dissaving is 7.0 percent per year. In

short, the population and the economy are rapidly moving towards extinction. One notable difference between Experiments 5 and 6 is that the male and female leisure indexes are much higher in the latter; even though the shift in preferences was entirely between fertility and consumption in Experiment 6, by the time all of the system interactions have worked themselves out the increases in leisure are of similar general magnitude to the increase in adult consumption.

The increased preference for consumption is offset entirely by a decreased preference for leisure in Experiment 7. The preference for children is not affected, but there is nonetheless a fall in the total fertility rate from the Experiment 1 benchmark level. At 1.9, the lower fertility rate produces a more moderate annual rate of system decline than in Experiments 5 and 6 -- 0.3 percent, compared with 0.8 and 1.6 percent. However, the qualitative effects are generally similar. A notable difference is the sharp fall in the leisure indexes (and by implication, the corresponding increases in labour force participation). Also of interest is the fact that the adult consumption level rises by only 12.5 percent in this experiment, compared to increases of 21.5 percent and 37.8 percent in the previous two. As before, this is a consequence of the complicated system interactions.

Increased Preference for Leisure

The final set of three experiments has a design pattern analogous to that of the previous two sets. An increased preference for leisure is represented by a transfer of 5 percent of lifetime wealth into the two leisure categories and out of the other cate-

gories. (The transfer of wealth is distributed pro rata between male and female leisure; that is to say, γ_1 and γ_2 are increased in the same proportion.) In Experiment 8, the offsets occur in both the consumption and fertility categories. In Experiment 9, only the consumption preference is affected, and in 10, only the fertility preference.

The total fertility rate is almost unchanged in Experiment 8, compared with Experiment 1. Indeed, to the level of rounding in Table 1 it is identical (at 2.1) in the two experiments. However, a very slight increase is evidenced by the small positive system growth rate in Experiment 8 (0.1 per annum), and the corresponding small differences in the population age distribution. In general, the macroeconomy is affected rather little by the shift in preferences. An exception is the real rate of interest, which is only 1.3 in Experiment 8, compared with 1.9 in Experiment 1. The shift in preferences is reflected in the higher levels of R_1 and R_2. However, even though the offsets in preferences occur in both the consumption and the fertility categories, ultimately this translates only into a reduced level of the consumption index; as noted, the level of fertility is affected hardly at all -- again an interesting consequence of the complicated system interactions.

When the offset occurs only in consumption, as in Experiment 9, the total fertility rate rises to 2.3 and the system grows a little faster (0.3 percent per annum). Other effects are generally as one might expect: the shift in age distribution is somewhat more pronounced than in Experiment 8, the net saving rate higher, the consumption index a little lower, and so on. In gen-

eral, the results of the two experiments are similar qualitatively, if a little different in magnitude.

The results of Experiment 10 are another matter. All of the offset to increased leisure preference occurs in the form of a reduced preference for children in this experiment, and the total fertility rate falls, in consequence, to 1.6. The system declines rapidly (1.1 percent per year), there is a high rate of dissaving, and the population is older, on average. The capital-output ratio rises to 5.0, the highest level in any of the ten experiments of Table 1, and concomitantly the real rate of interest falls to 1.0, which is the lowest level in any of the experiments. Adult consumption is at a much higher level in Experiment 10 than in the previous two, and the leisure indexes are substantially higher also.

What Does It All Mean?

We have discussed the details of the ten steady state experiments but these are mainly of academic interest. Of more relevance for present purposes are the general features of the results and the broad lessons that can be learned from them. Steady states are not of much practical interest in themselves; from a practical point of view, no one cares about what the population and the economy would look like after several hundred years if no other shocks occurred in the mean time! But the steady state characteristics of the system serve to isolate from transient effects the differences in underlying economic-demographic structure implied by different attitudes or preferences of the population, and especially of the younger adult population, where the impact on fertility and

family size is greatest. What then are the major lessons to be learned from these experiments?

There are perhaps three. The first -- and this is one to which we have alluded several times -- is that the real economic-demographic system (like the model one) is complex. Some of the outcomes of the experiments would have been predictable in advance, at least in qualitative terms. But others would have been much harder to foresee because of the interactions that take place between households and the macrosystem, and between the population and the economy. The economic and demographic effects of basic changes in social attitudes may be much more complicated and much less predictable than one might think at first glance.

The second lesson is that variations in fertility levels may imply very large changes in the resources available for the enjoyment of consumption goods or leisure. Children require both a share of the measured national product and large amounts of time in the form of child care. A reduction of fertility thus frees up output for adult use and time for adult leisure, or for use in the generating of income and a larger national product. The magnitudes of the potential increases in adult consumption and leisure are at least suggested by some of the experiments that we have discussed.

The third major lesson is that it does not take a very large shift in the allocation of lifetime wealth to bring about major changes in the rate of growth and structure of the population and the economy. All of the experiments discussed in this section involved a transfer of only 5 percent of lifetime wealth among categories of household use. But transfers of this size produced total fertility rates ranging from 1.4 to 2.8, annual growth rates

from -1.6 to 1.1 percent, and annual net savings rates from -7.0 to 4.6 percent. Adult consumption levels varied by as much as 68 percent (Experiment 6 compared with Experiment 3) and adult leisure by as much as 93 percent (the female leisure index in Experiment 10 compared with that of Experiment 4).

9. MODEL SIMULATION OF THE TIME PATH OF CANADIAN FERTILITY, 1936-86

We turn now to a quite different kind of experiment. This one, labeled Experiment 11, involves the use of the model to generate an economic-demographic system with a 50-year time path over which the total fertility rate is approximately the same as that of the actual Canadian total fertility rate from 1936 to 1986. To obtain such a result a large number of preliminary experiments were carried out with different patterns of household preferences and changes in preferences. The result is certainly not the actual path of the Canadian population and economy; many other events and circumstances not represented in the model have affected the historical evolution of the real economic-demographic system (the depression of the 1930s; World War II and its aftermath; large scale immigration, especially in the 1950s; the "energy shock" of the 1970s; the sequence of short to medium term "business cycles;" the uneven pattern of technological innovations and applications; and so on). The simulated time path is to be interpreted as representing the "pure" effects of shifts in household preferences and the demographic changes that they engender within the model environment. We use the model to "tell a story" that is consistent with Canadian fertility history, and by doing so we hope to gain some insights into what actually happened and the pressures that

were operative over the 50-year period. But the model is not the real world and the simulation is most certainly not historical fact.

What we have done is to find, by experimentation, a "reasonable" time path of γ values that would cause the model to generate a TFR series close to the actual one, as observed at five-year intervals from 1936 to 1986. The final values are specified in the description of Experiment 11 in the Summary of Experiments. The key parameter is γ_3, interpreted as the fraction of cohort lifetime wealth allocated to fertility. γ_3 starts off at 0.2100 in "1931" and is assumed to have been at that level throughout all previous history. (For convenience of exposition we refer to the dates in the simulation as if they were actual calendar years.) It then rises to 0.2400 by 1941. (Here, as elsewhere, all changes in γ values are assumed to take place linearly over ten years.) It rises still further, to 0.3000 by 1951, and then falls to 0.1700 by 1961 and to 0.1400 by 1971. The compensating adjustments (so that the γ values sum to 1) are made in γ_0, γ_1, and γ_2. (γ_4 is never changed.) The adjustments to these parameters are proportional in all cases. The implication is that changes in preferences for family size were offset by changes in the opposite direction in preferences for both consumption and leisure.

The story that we have spun with our model goes approximately as follows. From an initial situation in 1931, the preferences of young adults shifted gradually in favour of larger families during the 1930s, and the shift accelerated in the 1940s. But by the early 1950s a fundamental change had commenced; prefer-

ences now started to shift in the opposite direction. Large families were becoming less desirable in the minds of young people and an increasing emphasis was placed on consumption and leisure. This new shift in preferences gained momentum as the 1950s progressed. Thus, even as the baby boom was in full swing the seeds of its reversal were being sown. Preferences continued to shift away from children and in favour of a combination of more consumption and more leisure, and by the beginning of the 1960s it was clear from the aggregate statistics that fertility had started to decline: the baby bust had replaced the baby boom.

The shift in preferences was less extreme in the 1960s, and by the beginning of the 1970s it had stopped altogether; preferences had stabilized. But the legacy of the fundamental changes in attitudes that had take place in the 1950s and 1960s continued. Even though the preferences of each new adult cohort were the same as those of the one just before it, the nation's total fertility rate continued to fall during the 1970s as older cohorts passed out of the childbearing range and were replaced by younger ones with the new life styles. By the 1980s the rapid decline of the total fertility rate had come to an end but the rate was at the unprecedented low level of 1.7 children per woman, a figure well below the natural replacement level of 2.1. At its peak in the 1950s the rate had been 3.9. Thus it had fallen by some 56 percent in the space of a quarter century.

That the simulated series of total fertility rates does in fact correspond very closely to the actual historical series is evident from Table 2. The absolute differences between simulated

and actual rates are never greater than 0.2 over the period, and in eight of the eleven years the differences are 0.1 or less. Because the simulation starts at an arbitrary time (1936), has fixed mortality rates, and ignores immigration, it is not possible to track accurately the actual time path of the Canadian age distribution. The initial distribution is a function of demographic events extending well back into the 19th century and these, in turn, were affected by still earlier events. However, we wished to obtain results that would at least accord well with the Canadian demographic situation by 1986, the end of the simulation period. For one thing, that would give somewhat greater credibility to the historical simulation story. For another, it would provide a realistic starting point for the "future scenario" simulations to be discussed later. That the simulated and actual 1986 results are indeed in close conformity is evidenced by Table 2. The proportionate age distributions are very close and the crude birth rates are identical.

Let us see, then, how the model economic-demographic system as a whole evolved over the 50-year period in response to the changing patterns of cohort preferences. The results of the experiment are reported in Table 4. The format is the same as that of Table 1, except that the columns now represent years in simulated time and the variables shown as indexes have base 100.0 in 1936, the initial year of the simulation.

The effects of changing preferences on the life styles of young adult cohorts are apparent from the first four rows. Note the rise in F (planned fertility) up to 1951, and then the subse-

quent decline. The value of 4.5 in 1951 is considerably higher than the overall total fertility rate, TFR, even at its peak in 1956. This suggests that the shift in preferences of young people in the 1930s and 1940s was even more pronounced than the aggregate measures of the baby boom imply, and similarly that the subsequent shift in the opposite direction was more pronounced than indicated by the aggregate statistics of the baby bust. It suggests also what we have said before -- that the seeds of the bust were planted well before the boom actually ended.

As F increased in the 1930s and 1940s, C^*, R_1, and R_2 declined: young cohorts substituted children for personal consumption and leisure. In the 1950s, on the other hand, just the opposite occurred. Between 1951 and 1971, C^* rose by some 20 percent, R_1 by 39 percent, and R_2 by 31 percent, according to the model. By the 1980s the levels of C^*, R_1, and R_2 had risen still further. Clearly, the lower level of fertility chosen by young cohorts had released large amounts of both time and consumption goods. Much of the time released was used in leisure, but a significant portion was used also in the form of higher rates of female labour force participation.

The rise in the aggregate total fertility rate in the 1940s and 1950s was, of course, reflected in higher rates of population growth. The annual growth rate reached 1.8 percent in 1956, fell a little by 1961, and then fell very rapidly thereafter: in 1961, the rate was 1.6 percent; by 1971 it was only half as much, and by 1986 it had fallen to 0.6.

The rate of labour force growth followed a different but generally predictable time path. Some of the change in the labour

force (the measured labour force, that is, since the definition does not encompass child care in the home) was the result of variations in participation rates, but the larger part was associated with changes in fertility levels a decade and a half to two decades earlier. The delayed response of the labour force growth rate is roughly evident from a comparison of g(L) with g(N). In 1971 and 1976, g(L) was three times as great as g(N). By 1986, it was only about one-and-a-half times as great.

The rate of growth of the (real) national product varied over the 50-year period, although the variation was less pronounced than that of the rate of labour force growth. The rate of growth of output rose from 1.0 percent in 1951 and 1961 to 1.9 percent in 1976, and then fell to 1.5 percent by 1986.

The pattern of growth of the capital stock was different again. The stock grew over the whole half-century but the rate of growth was at its highest at the end of the period. In the years 1961 to 1966, the annual rate of increase was 0.7 percent; by 1986, it was 2.1 percent. Underlying this pattern were, of course, changes in rates of saving. Net saving was positive in every year but the rate of net saving moved up quite sharply after 1966: in 1966, 2.9 percent of output was saved; in 1986, 7.7 percent was saved.

The real rate of interest rose markedly in the simulation after 1956 and the capital-output ratio declined somewhat over the same period. Changes in the interest rate have widespread repercussions within the model, it may be noted. Higher rates imply greater returns to capital and tend to encourage saving and investment.

They also reduce the present value human wealth of a cohort by increasing the rate of discount of future earnings, and thereby tend to reduce current consumption. (There are, of course, other influences on consumption, including the reduction of the aggregate amount required by children following a drop in fertility.) Higher interest rates also tend to make earlier retirement relatively less expensive, since savings for retirement have a higher yield. The real rate of interest thus plays a key role in the model and its effects are rather complicated because of the ways in which it enters the life cycle planning process.

The changes in fertility are reflected in the pattern of change of the population age distribution. The proportion of children (persons under 15) reached a peak of 32.9 percent in the simulation in 1961. It then declined markedly, falling to only 21.7 percent by 1986. The proportion of elderly people (65 and over) rose somewhat after 1966, but most of the offset to the decline in the child population occurred in the population 15-64 -- the "economically active" population, so to speak. This and other influences on the labour force had a pronounced effect on the overall level of national output per capita: from an index level of 90.0 in 1961, Q/N rose to 110.3 by 1986, an increase of some 23 percent. At the same time, the relative youthfulness and inexperience of the labour force operated to some extent in the opposite direction and average labour productivity (Q/L^*) fell by four or five percent between the 1950s and the 1980s.

Summary Observations

As in the real world, the simulated economic-demographic

structure of 1986 was different in many ways from the structure of the 1950s and 1960s. Fertility rates were much lower and population growth much slower. The proportion of children in the population had been greatly reduced and the proportion in the economically active ages correspondingly increased. Savings rates were higher and output per capita was up sharply, in spite of a relatively less experienced labour force. National production was increasing at a faster rate than in the earlier period but the signs of change were evident; the rate of growth of output had been falling for a decade by 1986, and the rate of growth of the labour force for a decade and a half. The real rate of interest was still much higher than in the 1950s, although it had levelled off in the previous fifteen years or so. The life styles of younger adult cohorts were quite different from those of a generation earlier; the number of children that young people planned to have was down very sharply and their planned levels of both consumption and leisure were appreciably higher. It would have been obvious to observers in the model, as to those in the real world, that there would be major economic changes yet to come as the structure of the population continued to shift towards older ages and the rates of population and labour force growth continued to decrease. The change in life style had had a profound effect by 1986 and its impact would be felt far into the future.

10. WHAT IF THE HISTORY OF FERTILITY HAD BEEN DIFFERENT?

What if cohort preferences had not changed so markedly and there had been no baby boom or baby bust? Alternatively, what if the boom had continued, or had been followed by a more moderate decline in fertility than the one that actually occurred? What then

would be the situation today, compared with the actual one? To suggest some answers to these questions we have carried out three experiments with the model in which we again simulate the 50-year period 1936-86, but this time under different assumptions about the changes in the γ parameters. We refer to these experiments as "counterfactual historical" simulations.

No Baby Boom or Baby Bust

The first of these three simulation experiments, Experiment 12, makes the same assumptions as Experiment 11 for the period 1931-41, but assumes that no further changes in preferences took place after 1941. The results are reported in Table 5. The 1936 and 1941 columns of Table 5 are the same as the corresponding columns of Table 4, but the subsequent ones reflect the differing preferences.

The planned cohort fertility rate (F) rises only to 3.3 in Experiment 12 and remains almost constant thereafter. By 1976 it has settled at 3.2, and it holds that value through to 1986. The aggregate total fertility rate has a similar time pattern, although it does not become 3.2 until 1986. The rates of population growth, labour force growth, and growth of the economy generally are much less volatile over the simulation period, and much higher at the end. The population is growing at 1.6 percent per annum in 1986, the labour force at 1.7 percent, output at 1.6, and the capital stock at 1.4. The 1986 net rate of saving is positive, but not as high as before. In short, the economic-demographic system is expanding at a quite rapid pace, in contrast to the slow and declining growth generated in the "realistic"

Experiment 11. Output per capita is about 17 percent lower, in consequence mainly of lower labour force participation rates. Both planned adult consumption and the indexes of planned leisure are much lower too, reflecting the larger shares of national product consumed by children and the additional time requirements for child care. Cohort life styles are evidently thus quite different. So too is the age distribution of the population: 31.6 percent are under the age of 15 in Experiment 12, compared with only 21.7 in Experiment 11. Clearly, the society and the economy of today would be quite different had cohort preferences not varied historically in the manner that they did.

Baby Boom Maintained

The second of the "counterfactual historical" experiments, Experiment 13, assumes that preferences for children shifted in such a way as to produce the baby boom, as in Experiment 11, but that they remained stable after 1951. Thus there was a boom, according to this experiment, but no subsequent bust. The results are provided in Table 6.

The result of the "boom and no bust" experiment is a series of total fertility rates in excess of 4 from 1956 on, and a 1986 rate of 4.2. Conditioned as we are now to low fertility rates, it is hard to imagine such an outcome. Nevertheless, it is simply the result of not allowing cohort preferences to change after 1951.

The population and the economy are of course growing very rapidly in 1986, according to this experiment (2.5 percent per annum for the population, 2.6 for the labour force and the national

product). Planned adult consumption is only 74 percent of its level in Experiment 11, the leisure indexes are lower, especially the female leisure index (reflecting again the time requirements for the case of children in the home), and the age distribution of the population is skewed very sharply towards youth: 38.5 percent of the population are under 15. Output per capita is some 31 percent lower in Experiment 13 than in Experiment 11. Once again, the delayed impact of cohort preferences on the society and the economy are clearly evident.

Baby Boom Followed by Less Pronounced Fertility Decline

The final experiment in the "what if" trio, Experiment 14, supposes again a baby boom, as in Experiment 11, but that the boom was followed by a decline in fertility of more modest proportions than the actual one. Specifically, it assumes that the fertility preference parameter, γ_3, fell to 0.1700 by 1961, but that instead of falling further between 1961 and 1971 it remained constant at the 1961 level. Table 7 provides the results.

The planned fertility rate in this experiment rises to 4.5, as in Experiment 11, but then falls only to 2.1 by 1966, where it remains for the rest of the simulation period. The aggregate total fertility rate also falls to 2.1, reaching that level by 1981 and remaining there in 1986. The fertility rates of the 1980s are thus just at the natural replacement level. The population continues to grow because of the inherited age structure, although ultimately, of course, it must become stationary. Population growth in 1986 is higher in this experiment than in Experiment 11, but the rate of growth of output is the same in both experiments.

There is a slightly lower savings rate, the planned adult consumption level is somewhat lower and the indexes of planned leisure are also somewhat lower. The proportion of population under 15 is 24.7 percent, compared with 21.7 percent in Experiment 11. In general, the population and the economy of 1986 differ in detail between the two experiments, but broadly speaking they are much alike. The inference that one can make is that had the total fertility level in Canada fallen only to the natural replacement rate, instead of to 1.7 children per woman, the current state of the economic-demographic system would not be all that different from what it is. The consequences of having a population that is failing to reproduce itself lie much more in the future than in the present.

11. LOOKING AHEAD: ALTERNATIVE SCENARIOS FOR THE FUTURE

The final set of six experiments relates to the future -- or rather, the "future," we should say, since we are still in the artificial world of the model. As before, the six scenarios are based on alternative assumptions about the preferences of future cohorts of young people as they enter adulthood and make their life style decisions. As before too, we focus on γ_3, the parameter representing the proportion of anticipated lifetime wealth that households plan to spend on children. γ_0, γ_1, and γ_2 are adjusted proportionately in each of the experiments in order to compensate for changes in γ_3. The assumptions underlying the experiments are stated compactly in the Summary of Experiments.

The results of the "future scenarios" experiments are reported in Tables B-13. The format is the same as in the "historical" tables, except that those variables that are expressed

as indexes now have base 100.0 in 1986. The historical experiments covered the half-century from 1936 to 1986; the future scenarios cover the next half-century, 1986-2036. It is assumed, in all of the future scenario experiments, that the initial (1986) state of the population and the economy is the same as the final (1986) state generated by Experiment 11.

Preferences Unchanged

The first of the six experiments, Experiment 15, is the most natural one. It addresses the question, "What would the future look like if preferences remained unchanged?" The γ parameters thus retain the values that they had in 1986 in Experiment 11 (and indeed, the same values as in 1971, since Experiment 11 assumed no further change after that year). The results of Experiment 15 are provided in Table 8.

One of the interesting features of this scenario is that both planned fertility and the total fertility rate rise during the course of the experiment, even though the underlying preference structure is constant. The reason, of course, lies in the interplay between households and the macroeconomy, and in particular the feedback effects of changes in relative prices and the rate of interest on household decisions. The planned fertility rate reaches 2.1 by the end of the period, and the aggregate total fertility rate reaches 2.0. Thus the population appears to be very close to a situation in which it would maintain itself, in the long run. However, this is misleading. From other experiments we know that fertility will eventually decline. The underlying structure of preferences (the γ parameters) is such that planned fertility must

eventually fall below the replacement level, and the overall total fertility rate must eventually coincide with the planned rate. Nevertheless the result is an interesting one, suggesting, as it does, that by the early decades of the next century natural forces may operate so as to mitigate somewhat the tendency toward very low fertility.

Planned adult consumption rises substantially and the planned leisure indexes fall as the fertility rate moves up, a reflection in large part of the very sharp decline in the real rate of interest. The net rate of saving also falls sharply, and by 2026 it has turned negative. Output per capita rises over the first half of the simulation period, but by 2016 it has started to decline somewhat. The rise reflects increases in rates of labour force participation and higher average levels of experience in the labour force associated with changes in its composition; labour productivity (Q/L^*) increases by more than 20 percent over the simulation period (quite apart from changes in technology, from which the model abstracts). The falling off of the output per capita index after 2011 no doubt reflects the offsetting effects of the slower (and eventually negative) rates of capital accumulation.

The population continues to grow in Experiment 15 until the year 2006, but by 2016 it has started to decline, albeit at a rather moderate rate. The labour force starts to decline as early as 2006, and from 2016 to 2026 the average rate or reduction is about 1 percent per year. The national product, like the population, continues to increase until 2006, but then starts to decline by 2016.

The age structure of the population changes in a

predictable manner. The proportion of children in the population generally declines, although there is a slight increase at the very end of the simulation period. Concomitantly, the proportion 65 years of age and over rises more or less steadily -- from 10.7 percent in 1986, to 13.8 in 2011, and to 21.6 by 2031. "Population aging" is a clear and inevitable consequence of low fertility rates maintained over many decades.

Small Increase in Preference for Children

Experiment 16 assumes a small increase in the parameter representing preference for children after 1991: instead of remaining at 0.1400, as in Experiment 15, γ_3 rises to 0.1568 by 2001, where it remains until the end of the simulation period. The value of 0.1568 is chosen because that is the one that generates a stationary population and economy in the very long run (as in Experiment 1). The results of Experiment 16 are provided in Table 9.

The results are generally similar to those of the previous experiment, although, of course, there are differences in detail. As noted, the population would eventually become stationary if preferences were maintained at their new level, implying a total fertility rate of 2.1. However, TFR in fact rises somewhat above 2.1 during the period of the simulation; it reaches 2.2 by 2021 and 2.3 by 2031. Because of the age structure of the population, these levels are not sufficient to prevent the population from declining in the latter years of the simulation, although the rate of decline is low.

The effects on the economy are much the same as in Experiment 15: an "aging" population; slow and then negative

growth; a declining, and eventually negative net savings rate; a low real rate of interest; and so on. The main lesson to be learned from Experiment 16 is that there is nothing very special about a set of preferences that would produce a stationary population in the long run, at least as far as the next half-century is concerned. The achievement of a stationary state would take much longer than the fifty years of the simulation period even if the change in preferences were to begin as early as the 1990s.

Moderate Increase in Preference for Children

Experiment 17 assumes an increase in γ_3 from 0.1400 in 1991 to 0.2000 in 2001. For want of a better term we refer to this as a "moderate" increase. The results are to be found in Table 10.

The total fertility rate rises to 3.0 by the year 2026 in this experiment, again overshooting somewhat its ultimate level once the system has achieved a steady state. There is a corresponding increase in the proportion of children in the population, compared with the previous experiments in the present series. The population never declines over the simulation period, although the labour force decreases for some two decades or more in the first quarter of the next century. The real rate of interest falls, but not as sharply as before. Output per capita is substantially lower by the end of the simulation period, reflecting the larger proportion of children in the population as well as other factors. The net rate of saving follows a somewhat different path than before, although it still turns negative by the latter part of the period.

Large Increase in Preference for Children

The "large" increase in the preference for children in Experiment 18 takes the form of a rise in γ_3 to 0.2400 from 1991 to 2001. The effects, as evident from Table 11, are more or less similar in type to those of the earlier experiments in the series, but quantitatively different. The total fertility rate rises to 3.7 by the year 2026. Such a level seems almost inconceivable in the actual circumstances of today, but it should be remembered that 20th century Canadian demographic history is a history of huge swings in fertility: it is only three decades since the Canadian rate was almost 4, and the "future scenario" simulation that we are talking about here extends five decades into the future. In any event, it is worth noting that even with such a sharp turnaround in fertility, and the corresponding increase in the rate of population growth, the proportion of people 65 and over continues to rise until about three decades into the next century; it is only by the end of the simulation period that there is a decline in this proportion. The proportion is 16.2 percent in 2026, compared with 10.7 in 1986. Moreover, this is quite apart from any reduction of mortality that might come about over such a long period; the model takes mortality rates as fixed.

Of note also in this experiment is that the net savings rate still declines, and still goes negative in the latter part of the simulation period. Like the increase in the proportion of elderly people, the decline in the savings rate is a quite robust finding, even with marked differences in fertility assumptions and population growth rates.

Small Decrease in Preference for Children

We now allow preferences to shift in the opposite direction. γ_3 falls from 0.1400 to 0.1300 in Experiment 19, the drop taking place again over the decade 1991 to 2001. As shown in Table 12, this shift in household preferences away from children and towards consumption and leisure has the effect of keeping the aggregate total fertility rate at 1.7 until the year 2026, at which point it rises a little -- to 1.8 in 2026 and 1.9 by 2036. Thus the lessened preference for children simply acts so as to offset much of the tendency for TFR to rise to the natural replacement level during the simulation period, even if there is no shift in the underlying parameters. The other results of Experiment 19 are not greatly different from those of Experiment 15, although of course there is a somewhat more rapid rate of population decline by the latter part of the simulation period, a somewhat lower proportion of children and higher proportion of elderly in the population, and so on. But for the most part, the future would not look all that different if there were to be some further decrease in preferences for children.

Greater Decrease in Preference for Children

This final experiment, Experiment 20, is similar to the previous one except that γ_3 falls a little more sharply -- from 0.1400 in 1991 to 0.1200 by 2001. In consequence of the somewhat greater reduction of the planned proportion of cohort lifetime wealth allocated to children, the aggregate fertility rate does fall a little in this experiment: it is down to 1.6 by the year 2001, and 1.5 by 2011. However, it then rises, and by 2031 it is

back at 1.7, which is the 1986 level (both in the model simulation and in Canadian reality). It is again evident that there are pressures in the system that tend to support the total fertility rate, even in the face of decreases in preferences for children.

The other results of Experiment 20 are much as one would expect. The real interest rate falls to 0.2 percent per annum by the end of the period, and the capital-output ratio rises to 5.8, the highest ratio in any of the "future scenario" experiments. A real interest rate of 0.2 is almost inconceivable in the real world, but it should be remembered that the model abstracts from technological progress, which would tend to raise the rate. Indeed, at a more general level one can say that unless there is an increase in preference for children of a magnitude that seems unlikely to a present-day observer, any significant expansion of the economy must come from advances in technology, at least by the end of the first decade of the next century.

A Final Observation

In concluding this section, it is worth noting that all of the "future scenario" experiments generate roughly similar macroeconomic states up until about 20 years into the simulation period. One can infer this readily by comparing the results of Experiment 18 with those of Experiment 20. These two experiments represent the extremes -- the greatest increase in preference for children in the one case, the greatest decrease in the other. A comparison of the 2006 columns of Tables 11 and 13 indicates almost no difference in savings rates, productivity levels, capital-output ratios, real rates of interest, and rates of growth of the capital

stock. The differences in rates of growth of output, labour force, and productivity-weighted labour input are also quite small. There are, of course, big differences on the demographic side -- in total fertility rates, birth rates, and population growth rates -- but the differences in economic effects still lie mostly in the future at this point in the simulation. The only notable exception is the difference in the levels of output per capita: output per capita is some 5 percent lower in Experiment 18 than in Experiment 20. The point of this comparison is that whatever happens to household preferences and levels of fertility in the future, the macroeconomy is likely to be much the same for at least two decades. While fertility changes do have fundamental effects on the macroeconomy, many of these effects come to be felt in full only over quite long periods.

12. SUMMARY AND CONCLUSIONS

We noted early in this paper that decisions about family size -- about fertility, that is -- are essentially life cycle decisions, in the sense in which that term is used in economic theory. Children imply costs to their parents, both in terms of consumption requirements and in terms of time requirements for child care. Moreover, implicitly if not explicitly, such decisions are made jointly with decisions about adult consumption levels, leisure time (and hence time spent in the labour force), and provision for bequests or contingency allowances. A household's lifetime wealth, including the present value of its expected future earnings, serves to constrain the choices that it can make; a larger number of children implies less of something else, and

conversely. The household thus faces a constrained optimization problem precisely of the kind posited in life cycle theory. It can be thought of as maximizing a lifetime utility function in which children, leisure time, consumption, and bequest or contingency allowances enter as arguments. The constrained optimum solution depends on the relative shadow prices of the arguments, as well as on the amount of lifetime wealth available.

The parameters of the household's utility function define its relative preferences. When preferences shift the parameters take on new values, and the solution to the household optimization problem changes. This has fundamental implications not only for the "life styles" of individuals, but also for the population as a whole and for the macroeconomy. Aggregate fertility levels may be affected, thus setting in motion changes in the size, growth rate, and age distribution of the population. Labour force participation rates may change too, and these, together with changes in population structure, have implications for the productive capacity of the economy and the income that it is able to generate. Rates of consumption, savings, and capital accumulation are affected. So too are interest rates, wage rates, and other variables entering the decision processes of individual households. Thus there is a feedback effect from the macrosystem to the microsystem. Households revise their expectations, taking account of altered shadow prices of children, leisure, and consumption, and make new decisions, which in turn affect the macroeconomy; and so it goes. This continuous interaction between microeconomic optimizing decisions and the workings of the macroeconomy induces complex dynamics in the economic-demographic system. The goal of the paper has been to

illuminate these dynamics and to interpret them in a way that has relevance for the Canadian situation.

A formal micromodel of life cycle choice was developed along the foregoing lines. A macromodel of an integrated economic-demographic system was then developed, with the micromodel at its base. The macromodel included equations representing population dynamics, labour force and employment, an aggregate production process, income generation and the determination of wage and interest rates, the processes of private consumption and savings, the determination of wealth and its intercohort transmission through bequests and inheritances, the determination of investment and the stock of capital, and the generation of government revenue through taxation and the use of this revenue for government consumption. The model was designed so as to be able to track the evolutionary path of the economic-demographic system over long periods as it responds to changes in underlying preferences at the microlevel. The model represented a hypothetical population and economy but where possible its parameters were given values roughly in accord with Canadian experience.

The integrated macromodel was used in a series of twenty computer simulation experiments, divided into four groups. In the first group, ten steady states were simulated. That is to say, ten different sets of household preferences were assumed (i.e., ten different sets of utility function parameters), and the model was allowed to run in artificial time for as long as was required for it to achieve final equilibrium states. In each case the change in preferences represented a transfer of 5 percent of lifetime wealth

among children, leisure, and consumption. These experiments served to bring out the complexity of the economic-demographic system and the difficulties of predicting the long-run macro-effects of changes in household preferences or "life styles." They served also to indicate that changes in household fertility may imply very large changes in the resources available for alternative use in the form of higher levels of consumption or greater amounts of leisure time. A third inference from this first set of experiments was that it does not take a very large shift in the allocation of household lifetime wealth to bring about major changes in the rate of growth and structure of the population and the economy; transfers of only 5 percent at the micro-level were sufficient to effect massive transformations of the macrosystem.

The next experiment involved using the model to simulate the time path of Canadian fertility over the half-century from 1936 to 1986, including both the "baby boom" and the subsequent "baby bust" of that period. A pattern of change in the preferences of successive cohorts of young adults was found experimentally that caused the model to approximate very closely the actual historical time path, and to yield a "1986" population with characteristics very similar to those of the actual 1986 Canadian population. The successful simulation involved shifts in the preferences of young adults in favour of larger families during the 1930s and 1940s, and then in the opposite direction during the 1950s and 1960s. The shift was much more moderate in the 1960s; most of the drastic revisions that occurred in social attitudes or preferences, and which gave rise to the "baby bust," could be assumed to have taken place among young people in the 1950s. No further shifts at all

were required after 1971. The total fertility rate, both simulated and actual, was 1.7 children per woman in 1986, a rate well below the long-run natural replacement level of 2.1.

Three experiments referred to as "counterfactural historical" simulations were then carried out. The first was based on preferences that are unchanged after 1941, and thus assumed away both the baby boom and the baby bust. The result was a much smoother time path of fertility and of the economic-demographic system generally, a larger proportion of children in the population in 1986, a faster rate of growth, and a lower level of national output and income per capita. In short, the 1986 economy and population would have been quite different had there been no boom and bust.

The 1986 economy and the population would have differed even more from the actual ones had there been a baby boom and no subsequent bust, as in the second of these three experiments. (Preferences were assumed in this experiment to remain constant after 1951.) Growth would have been very rapid and sustained, national output and income per capita even lower in 1986, and the proportion of children even higher.

The last of the "counterfactual historical" simulations assumed a baby boom followed by a decline in fertility, but a more modest decline than the one that actually occurred in Canada in the 1960s and 1970s. This experiment produced a 1986 total fertility rate of 2.1 (the natural replacement rate), as compared with an actual 1986 rate of 1.7. The experiment suggested that had the total fertility rate in fact been at the natural replacement level,

instead of well below it, the economy and the population of today would not be markedly different from the actual ones; there would be some differences, of course, but not major ones. The more pronounced differences would still lie ahead.

The final six simulation experiments pertained to the "future," as defined by the model. These simulations took the 1986 results of the "realistic" historical simulation as a starting point and generated time paths for the half-century ending in 2036, again under alternative assumptions about the preferences of successive cohorts of young adults. (Some of these cohorts were in the population as children at the start of the simulations and some had yet to be born.) One of the six experiments assumed no change in cohort preferences over the whole period; three assumed shifts of various degrees towards children (with compensatory lessening of preferences for consumption and leisure); and two assumed shifts away from children.

One notable feature of these "future scenario" experiments was that the total fertility rate tended to rise somewhat during the simulations, even when preferences remained unchanged. Ultimately the rate would have to fall again, but that would be beyond the simulation period -- more than half a century into the future. Another result was that the proportion of elderly people in the population increased over most or all of the simulation period even when fertility rates were allowed to move up sharply, starting in the early 1990s -- and of course, when fertility rates did not move up as sharply, or were allowed to fall, the increases in the elderly proportion were much greater. A larger fraction of elderly people thus seems virtually inevitable, whatever the course

of fertility in future decades.

Other characteristics of the "futures" simulations generally were a declining rate of growth of the national product throughout much or all of the period, a lower rate of saving (even negative net saving by the latter part of the period), a falling real rate of interest, an increasing ratio of capital to output, and higher levels of average labour productivity. The latter was largely a consequence of a somewhat older and more experienced labour force.

The simulations suggested that there would in fact be major changes in the economy as a result of inevitable changes in the age structure of the population, and perhaps still greater changes if preferences for children shift. But for the most part these are several decades away. Whatever happens to household preferences and fertility levels, the macroeconomy is likely to be little affected for at least two decades. Fertility changes can indeed have fundamental effects on the macroeconomy, but many of these effects require quite long periods before they are fully realized.

FOOTNOTE

1. In a series of influential and controversial studies, Richard Easterlin has been instrumental in focussing attention on such interactions, although not in an explicit life cycle framework such as is developed here. (See, for example, Easterlin 1962, 1966a, 1966b, 1968, 1969, 1973, 1978.) Those who have participated in the ensuing discussion include Ahlburg (1982), Ben-Porath (1975), Butz and Ward (1979), Denton and Spencer (1975, Chs. 3, 10), Easterlin, Wachter, and Wachter (1978a, 1978b), Lee (1976, 1981, 1987), Moffit (1982), Samuelson (1976), Schultz (1987), Wachter (1975), and Ward and Butz (1980). Among the few analyses specifically concerned with various macroeconomic implications of microeconomic optimizing behaviour are Cigno (1988), Barro and Becker (1988), Denton and Spencer (1983, 1984, 1988), and Lee and Lapkoff (1988).

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EQUATIONS OF THE MACROMODEL

POPULATION

(1) $\left\{F_{jt} = \text{opt}\ F \,\middle|\, E(w,h,r,\tau) \text{ at age 18 in year } t-j+18\right\}$ $(j \geq 18)$

(2) $f_{jt} = \varphi_j F_{jt}$ $(18 \leq j < 50)$

(3) $f_{jt} = \varphi_j F_{18,t}$ $(j = 15,16,17)$

(4) $f_{jt} = 0$ $(j \leq 14; j \geq 50)$

(5) $B_t = \sum_{j=15}^{50} \left[1/2(f_{jt}+f_{j-1,t-1}) \cdot 1/2(N_{2jt}+N_{2,j-1,t-1})\right]$

(6) $B_{1t} = \left(s/(1+s)\right)B_t; \qquad B_{2t} = \left(1/(1+s)\right)B_t$

(7) $N_{ijt} = (1-d_{ijt})N_{i,j-1,t-1}$ $(i = 1,2; j \geq 1)$

(8) $N_{i0t} = (1-d_{i0t})B_{it}$ $(i = 1,2)$

(9) $N_{jt} = N_{1jt} + N_{2jt}$ $(j \geq 0)$

(10) $N_t = \sum_{j \geq 0} N_{jt}$

LABOUR FORCE AND EMPLOYMENT

(11) $p_{ijt} = \text{opt}\left\{p_{ij} \,\middle|\, E(w,h,r,\tau) \text{ at age 18 in year } t-j+18\right\}$ $(i = 1,2; j \geq 18)$

(12) $p_{ijt} = p_{ij,t-1} + \eta_{ij}(p_{i,18,t} - p_{i,18,t-1})$ $(i = 1,2; j = 15,16,17)$

(13) $L_{ijt} = p_{ijt}N_{ijt}$ $(i = 1,2; j \geq 15)$

(14) $L'_{ijt} = (1-u_{ij})L_{ijt}$ $(i = 1,2; j \geq 15)$

(15) $L_t = \sum_i \sum_{j \geq 15} L_{ijt}$

(16) $L_t' = \sum_i \sum_{j \geq 15} L_{ijt}'$

PRODUCTION

(17) $Q_t = \alpha (K_t)^{\beta} (L_t^*)^{1-\beta}$

(18) $L_t^* = \sum_i \sum_{j \geq 15} q_{ij} L_{ijt}'$

INCOME AND FACTOR RETURNS

(19) $w_{ijt} = (1-\beta)(Q_t / L_t^*) q_{ij}$ $(i=1,2; j \geq 15)$

(20) $w_t = (1-\beta)(Q_t / L_t')$

(21) $r_t = \beta (Q_t / K_t) - \delta$

(22) $Y_{jt} = \sum_i w_{ijt} L_{ijt}' + r_t W_{jt}$ $(j \geq 15)$

(23) $Y_t = \sum_{j \geq 15} Y_{jt}$

PRIVATE CONSUMPTION AND SAVINGS

(24) $C_{jt}^{**} = \text{opt} \left\{ C_j^{**} \middle| E(w,h,r,\tau) \text{ at age } j \text{ in year } t \right\}$ $(j \geq 18)$

(25) $C_{jt} = 1/2 (N_{jt} C_{jt}^{**})$ $(j \geq 18)$

(26) $C_{jt} = (1-\tau_t) Y_{jt}$ $(j=15,16,17)$

(27) $S_{jt}' = (1-\tau_t) Y_{jt} - C_{jt}$ $(j \geq 15)$

(28) $C_t = \sum_{j \geq 15} C_{jt}$

(29) $S'_t = \sum_{j \geq 15} S'_{jt}$

(30) $S_t = S'_t + \delta K_t$

WEALTH AND INHERITANCE

(31) $W_{jt} = W_{j-1,t-1} + S'_{j-1,t-1} + \phi_j \sum_{k>18} H_{kt} - H_{jt}$ $(j>18)$

(32) $W_{jt} = 0$ $(j \leq 18)$

(33) $H_{jt} = \left[\left(\sum_i d_{ijt} N_{i,j-1,t-1}\right) / N_{jt}\right] \left[W_{j-1,t-1} + S'_{j-1,t-1}\right]$ $(j>18)$

(34) $W_t = \sum_{j>18} W_{jt}$

INVESTMENT AND CAPITAL STOCK

(35) $I_t = S_t$

(36) $K_t = W_t$

(37) $K_t = (1-\delta)K_{t-1} + I_{t-1}$

GOVERNMENT CONSUMPTION AND TAXES

(38) $G_t = \sum_{k=1}^{5} \theta_k Q_{t-k}$

(39) $T_t = G_t$

(40) $\tau_t = T_t / Y_t$

DEFINITIONS OF SYMBOLS USED IN THE MACROMODEL

Greek symbols

α -- production function scale parameter

β -- production function distribution parameter

δ -- annual depreciation rate

η -- participation rate adjustment parameter

θ -- government expenditure parameter

ξ -- inheritance share parameter

τ -- income tax rate

φ -- fertility parameter

Latin symbols

B -- annual live births

B_1 -- male live births

B_2 -- female live births

C -- private consumption

C^{**} -- private consumption per household unit

d -- mortality rate

E -- expectation operator

F -- total cohort fertility rate

f -- age-specific fertility rate

G -- government consumption

H -- cohort wealth transfer at death

h -- inheritance received per person

I -- gross investment

i -- sex subscript (male 1, female 2)

j -- age subscript

K -- capital stock (start of year)

k -- supplementary subscript for age or time lag

L -- labour force

L' -- employed labour force

L^* -- productivity-weighted labour input

N -- population

opt -- lifecycle optimization operator

p -- labour force participation rate

Q -- gross output

q -- age-sex productivity weight

r -- interest rate (net return to capital)

S -- gross saving (before depreciation allowance)

S' -- net saving (after depreciation allowance)

s -- male-female birth ratio

T -- total taxes

t -- time subscript

u -- unemployment rate

W -- realized wealth (start of year)

w -- wage rate

Y -- net income (before tax)

SUMMARY OF EXPERIMENTS

Steady State Experiments

Exp. 1 -- Baseline experiment; household preferences are such as to produce a stationary population and a stationary economy: $\gamma_0 = 0.5754$; $\gamma_1 = 0.0639$; $\gamma_2 = 0.1044$; $\gamma_3 = 0.1568$; $\gamma_4 = 0.0995$.

Exp. 2 -- Five percent of household lifetime wealth is reallocated to accommodate increased preference for children offset by decreased preference for both consumption and leisure: $\gamma_0 = 0.5367$; $\gamma_1 = 0.0596$; $\gamma_2 = 0.0974$; $\gamma_3 = 0.2068$; $\gamma_4 = 0.0995$.

Exp. 3 -- Five percent of household lifetime wealth is reallocated to accommodate increased preference for children offset by decreased preference for consumption alone: $\gamma_0 = 0.5254$; $\gamma_1 = 0.0639$; $\gamma_2 = 0.1044$; $\gamma_3 = 0.2068$; $\gamma_4 = 0.0995$.

Exp. 4 -- Five percent of household lifetime wealth is reallocated to accommodate increased preference for children offset by decreased preference for leisure alone: $\gamma_0 = 0.5754$; $\gamma_1 = 0.0449$; $\gamma_2 = 0.0734$; $\gamma_3 = 0.2068$; $\gamma_4 = 0.0995$.

Exp. 5 -- Five percent of household lifetime wealth is reallocated to accommodate increased preference for consumption offset by decreased preference for both leisure and children: $\gamma_0 = 0.6254$; $\gamma_1 = 0.0540$; $\gamma_2 = 0.0884$; $\gamma_3 = 0.1327$; $\gamma_4 = 0.0995$.

Exp. 6 -- Five percent of household lifetime wealth is reallocated to accommodate increased preference for consumption offset by decreased preference for children alone: $\gamma_0 = 0.6254$; $\gamma_1 = 0.0639$; $\gamma_2 = 0.1044$; $\gamma_3 = 0.1068$; $\gamma_4 = 0.0995$.

Exp. 7 -- Five percent of household lifetime wealth is reallocated to accommodate increased preference for consumption offset by decreased preference for leisure alone: $\gamma_0 = 0.6254$; $\gamma_1 = 0.0449$; $\gamma_2 = 0.0734$; $\gamma_3 = 0.1568$; $\gamma_4 = 0.0995$.

Exp. 8 -- Five percent of household lifetime wealth is reallocated to accommodate increased preference for leisure offset by decreased preference for both consumption and children: $\gamma_0 = 0.5361$; $\gamma_1 = 0.0828$; $\gamma_2 = 0.1355$; $\gamma_3 = 0.1461$; $\gamma_4 = 0.0995$.

Exp. 9 -- Five percent of household lifetime wealth is reallocated to accommodate increased preference for leisure offset by decreased preference for consumption alone: $\gamma_0 = 0.5254$; $\gamma_1 = 0.0828$; $\gamma_2 = 0.1355$; $\gamma_3 = 0.1568$; $\gamma_4 = 0.0995$.

Exp. 10 -- Five percent of household lifetime wealth is reallocated to accommodate increased preference for leisure offset by decreased preference for children alone: $\gamma_0 = 0.5754$; $\gamma_1 = 0.0828$; $\gamma_2 = 0.1355$; $\gamma_3 = 0.1068$; $\gamma_4 = 0.0995$.

"Actual" Historical Simulation Experiment

Exp. 11 -- Household preferences are adjusted to simulate the actual historical time path of the Canadian total fertility rate: $\gamma_3 = 0.2100$ up to and including 1931, rises to 0.2400 by 1941 and 0.3000 by 1951, then falls to 0.1700 by 1961 and 0.1400 by 1971, remaining constant thereafter; compensating proportionate adjustments are made to γ_0, γ_1, and γ_2 so that the same ratios are maintained among these three parameters as in Exp. 1; γ_4 is the same as in Exp. 1 throughout the simulation.

Counterfactual Historical Simulation Experiments

Exp. 12 -- Household preferences are adjusted to simulate the historical time path of the Canadian total fertility rate as it would have been if there had been no baby boom or baby bust: γ_3 is the same as in Exp. 11 up to and including 1941 but remains constant at 0.2400 after 1941; compensating proportionate adjustments are made to γ_0, γ_1, and γ_2, as in Exp. 11.

Exp. 13 -- Household preferences are adjusted to simulate the historical time path of the Canadian total fertility rate as it would have been if the baby boom had been maintained: γ_3 is the same as in Exp. 11 up to and including 1951 but remains constant at 0.3000 after 1951; compensating proportionate adjustments are made to γ_0, γ_1, and γ_2, as in Exp. 11.

Exp. 14 -- Household preferences are adjusted to simulate the historical time path of the Canadian total fertility rate as it would have been if the baby boom had been followed by a less pronounced decline in fertility than in the actual baby bust; γ_3 is the same as in Exp. 11 up to and including 1961 but remains constant thereafter at 0.1700; compensating proportionate adjustments are made to γ_0, γ_1, and γ_2, as in Exp. 11.

Future Scenario Experiments

Exp. 15 -- Household preferences are unchanged from 1986 to 2036: γ_0, γ_1, γ_2, γ_3, and γ_4 have the same values as in 1986 in Exp. 11.

Exp. 16 -- Small increase in preference for children: γ_0, γ_1, γ_2, γ_3, and γ_4 are unchanged from 1986 to 1991; γ_3 then rises from 0.1400 in 1991 to 0.1568 by 2001, remaining constant thereafter; compensating proportionate adjustments are made to γ_0, γ_1, and γ_2. (Note: The values of the γ parameters attained by 2001 are the same as in Exp. 1; they would produce a stationary population and a stationary economy if maintained indefinitely.)

Exp. 17 -- Moderate increase in preference for children: same as Exp. 16 except that γ_3 rises from 0.1400 in 1991 to 0.2000 by 2001.

Exp. 18 -- Large increase in preference for children: same as Exp. 16 except that γ_3 rises from 0.1400 in 1991 to 0.2400 by 2001.

Exp. 19 -- Small decrease in preference for children: same as Exp. 16 except that γ_3 falls from 0.1400 in 1991 to 0.1300 by 2001.

Exp. 20 -- Greater decrease in preference for children: same as Exp. 16 except that γ_3 falls from 0.1400 in 1991 to 0.1200 by 2001.

TABLE 1 CONSUMPTION AND DEMOGRAPHIC EFFECTS OF PREFERENCE STEP STATE TEST OF ALTERNATIVE REALLOCATIONS OF 5 PERCENT OF LIFETIME WEALTH (EXPERIMENTS 1-10)

	Exp.1	Exp.2	Exp.3	Exp.4	Exp.5	Exp.6	Exp.7	Exp.8	Exp.9	Exp.10
Life style variables										
(new cohort)										
C^*	100.0	83.9	82.0	90.7	121.5	137.8	112.5	93.9	89.5	118.9
R_1	100.0	97.1	102.0	79.2	98.5	132.6	82.4	117.0	116.9	129.8
R_2	100.0	91.2	96.5	72.4	97.2	131.0	78.5	122.2	120.7	139.4
F	2.1	2.8	2.8	2.6	1.7	1.4	1.9	2.1	2.3	1.6
Population and the macroeconomy										
TFR	2.1	2.8	2.8	2.6	1.7	1.4	1.9	2.1	2.3	1.6
B/N	13.6	19.8	20.4	18.2	9.5	6.9	11.8	13.9	15.4	8.4
$\%N_{0-14}$	20.0	27.1	27.6	25.3	15.0	11.4	17.9	20.4	22.2	13.4
$\%N_{65+}$	17.0	11.3	10.9	12.5	22.6	27.9	19.2	16.6	15.0	24.8
g(N)	0.0	1.1	1.1	0.8	-0.8	-1.6	-0.3	0.1	0.3	-1.1
g(L)	0.0	1.1	1.1	0.8	-0.8	-1.6	-0.3	0.1	0.3	-1.1
$g(L^*)$	0.0	1.1	1.1	0.8	-0.8	-1.6	-0.3	0.1	0.3	-1.1
g(Q)	0.0	1.1	1.1	0.8	-0.8	-1.6	-0.3	0.1	0.3	-1.1
g(K)	0.0	1.1	1.1	0.8	-0.8	-1.6	-0.3	0.1	0.3	-1.1
r	1.9	2.5	2.5	2.9	2.0	2.0	2.4	1.3	1.5	1.0
K/Q	4.4	4.0	4.0	3.8	4.3	4.3	4.0	4.7	4.6	5.0
Q/L^*	100.0	96.0	96.5	94.4	99.0	99.0	96.7	103.4	102.4	105.8
Q/N	100.0	91.6	90.3	96.1	101.5	91.5	103.7	97.9	96.2	96.8
S/Q	21.9	24.1	24.7	22.2	17.8	14.3	18.8	23.9	24.7	19.2
S'/Q	0.0	4.2	4.6	3.1	-3.6	-7.0	-1.4	0.3	1.6	-5.7

Note: C^* stands for initial planned consumption per adult, R_1 and R_2 for planned lifetime leisure of males and females, and F for planned total fertility rate; TFR is actual total fertility rate (per woman) based on cross-section data for given year; $\%N_{0-14}$ and $\%N_{65+}$ are percentages of total population 0-14 years of age and 65 and over; $g(\cdot)$ is annual percentage growth rate; other symbols are as defined for the macromodel. C^*, R_1, R_2, Q/L^*, and Q/N are expressed as indexes relative to base level 100.0 in Exp.1; B/N is per thousand population; r, S/Q, and S'/Q are percentages.

TABLE 2: COMPARISON OF ACTUAL AND SIMULATED TOTAL FERTILITY RATES, 1936-1986

Year	Actual TFR	Simulated TFR	Difference
1936	2.7	2.8	0.1
1941	2.8	3.0	0.2
1946	3.4	3.2	-0.2
1951	3.5	3.6	0.1
1956	3.9	3.9	0.0
1961	3.8	3.6	-0.2
1966	2.8	2.8	0.0
1971	2.2	2.2	0.0
1976	1.8	1.9	0.1
1981	1.7	1.7	0.0
1986	1.7	1.7	0.0

Note: Actual TFR for 1986 is a preliminary estimate.

TABLE 3: COMPARISON OF ACTUAL AND SIMULATED AGE DISTRIBUTIONS AND CRUDE BIRTH RATES, 1986

	Actual	Simulated	Difference
% population under 15	21.4	21.7	0.3
% population 15- 64	68.0	67.6	-0.4
% population 65+	10.7	10.7	0.0
Crude birth rate (per 1000 pop.)	14.7	14.7	0.0

TABLE 4: SIMULATED HISTORICAL BABY BOOM AND BABY BUST (EXPERIMENT 11)

	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986
Life style variables											
(new cohort)											
C^*	100.0	97.9	93.5	89.2	98.6	107.2	107.6	107.3	105.9	106.5	109.1
R_1	100.0	97.5	92.8	87.8	97.2	108.1	114.0	122.1	127.3	130.2	128.4
R_2	100.0	97.6	93.1	88.4	97.8	107.8	111.2	115.5	117.7	119.4	119.8
F	3.1	3.3	3.9	4.5	3.2	2.2	1.9	1.7	1.7	1.7	1.7
Population and the macroeconomy											
TFR	2.8	3.0	3.2	3.6	3.9	3.6	2.8	2.2	1.9	1.7	1.7
B/N	20.5	21.3	22.9	25.3	26.4	24.0	19.7	16.6	15.6	15.4	14.7
$\%N_{0-14}$	27.5	27.8	28.5	29.9	31.8	32.9	32.0	28.9	25.2	22.7	21.7
$\%N_{65+}$	11.0	10.9	10.8	10.6	10.3	10.0	9.9	10.0	10.2	10.4	10.7
g(N)	1.1	1.2	1.4	1.7	1.8	1.6	1.1	0.8	0.7	0.7	0.6
g(L)	1.1	1.1	1.0	0.9	1.1	1.6	2.1	2.4	2.1	1.5	0.9
$g(L^*)$	1.1	1.1	1.0	1.0	1.1	1.4	1.8	2.1	2.1	1.7	1.2
g(Q)	1.1	1.1	1.1	1.0	1.0	1.2	1.5	1.8	1.9	1.8	1.5
g(K)	1.1	1.1	1.2	1.1	0.9	0.7	0.7	1.1	1.5	2.0	2.1
r	2.6	2.6	2.5	2.5	2.5	2.7	2.9	3.2	3.4	3.4	3.2
K/Q	4.0	4.0	4.0	4.0	4.0	3.9	3.8	3.7	3.6	3.6	3.6
Q/L^*	100.0	100.1	100.2	100.4	100.3	99.6	98.2	96.6	95.6	95.5	96.5
Q/N	100.0	99.6	98.4	96.0	92.6	90.0	90.2	93.7	99.2	105.0	110.3
S/Q	24.3	24.3	24.5	24.2	23.3	22.4	21.9	22.8	23.6	25.0	25.9
S'/Q	4.5	4.5	4.6	4.2	3.3	2.9	2.9	4.5	5.8	7.2	7.7

Note: The note to Table 1 applies to this table except that indexes are relative to base level 100.0 in 1936.

TABLE 5: COUNTERFACTUAL HISTORICAL SIMULATION: NO BABY BOOM OR BABY BUST (EXPERIMENT 12)

	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986
Life style variables											
(new cohort)											
C^*	100.0	97.9	98.0	98.0	97.6	96.9	96.1	95.4	94.8	94.2	93.5
R_1	100.0	97.5	97.3	97.1	97.3	98.1	99.4	101.2	103.2	105.1	107.0
R_2	100.0	97.6	97.5	97.4	97.4	97.5	98.0	98.7	99.6	100.3	101.0
F	3.1	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.2	3.2	3.2
Population and the macroeconomy											
TFR	2.8	3.0	3.1	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.2
B/N	20.5	21.3	22.4	23.0	23.1	23.1	23.4	23.9	24.1	24.1	23.9
$\%N_{0-14}$	27.5	27.8	28.4	29.3	30.1	30.5	30.7	30.9	31.2	31.5	31.6
$\%N_{65+}$	11.0	10.9	10.8	10.7	10.5	10.4	10.2	10.0	9.8	9.5	9.3
g(N)	1.1	1.2	1.3	1.4	1.4	1.5	1.5	1.6	1.6	1.6	1.6
g(L)	1.1	1.1	1.0	1.1	1.2	1.4	1.5	1.6	1.6	1.7	1.7
$g(L^*)$	1.1	1.1	1.1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.7
g(Q)	1.1	1.1	1.1	1.1	1.1	1.2	1.3	1.4	1.5	1.5	1.6
g(K)	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.1	1.2	1.3	1.4
r	2.6	2.6	2.6	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2
K/Q	4.0	4.0	4.0	4.0	4.0	3.9	3.9	3.8	3.8	3.7	3.7
Q/L^*	100.0	100.1	100.2	100.2	100.0	99.6	99.0	98.4	97.8	97.3	96.7
Q/N	100.0	99.6	98.6	97.0	95.4	94.1	93.1	92.3	91.7	91.2	91.1
S/Q	24.3	24.3	24.3	24.0	23.7	23.4	23.3	23.3	23.3	23.3	23.4
S'/Q	4.5	4.5	4.4	4.1	3.9	3.8	4.0	4.3	4.5	4.8	5.1

Note: The note to Table 1 applies to this table except that indexes are relative to base level 100.0 in 1936.

TABLE 6: COUNTERFACTUAL HISTORICAL SIMULATION: BABY BOOM MAINTAINED (EXPERIMENT 13)

	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986
Life style variables											
(new cohort)											
C^*	100.0	97.9	93.5	89.2	89.0	88.3	87.1	85.4	83.6	81.9	80.4
R_1	100.0	97.5	92.8	87.8	87.5	87.8	89.6	92.8	97.9	104.0	110.4
R_2	100.0	97.6	93.1	88.4	88.1	88.1	88.5	89.7	91.5	93.9	96.3
F	3.1	3.3	3.9	4.5	4.5	4.5	4.4	4.4	4.3	4.2	4.1
Population and the macroeconomy											
TFR	2.8	3.0	3.2	3.6	4.1	4.4	4.4	4.4	4.4	4.3	4.2
B/N	20.5	21.3	22.9	25.3	27.5	28.8	29.2	29.8	30.8	31.6	31.7
$\%N_{0-14}$	27.5	27.8	28.5	29.9	32.0	34.2	35.8	36.7	37.2	37.9	38.5
$\%N_{65+}$	11.0	10.9	10.8	10.6	10.3	9.8	9.4	8.9	8.4	7.8	7.3
g(N)	1.1	1.2	1.4	1.7	1.9	2.1	2.1	2.2	2.4	2.5	2.5
g(L)	1.1	1.1	1.0	0.9	1.0	1.3	1.7	2.1	2.4	2.5	2.6
$g(L^*)$	1.1	1.1	1.0	1.0	1.0	1.2	1.5	1.9	2.2	2.4	2.6
g(Q)	1.1	1.1	1.1	1.0	1.0	1.1	1.3	1.6	1.8	2.1	2.3
g(K)	1.1	1.1	1.2	1.1	1.0	0.8	0.7	0.8	1.0	1.3	1.6
r	2.6	2.6	2.5	2.5	2.5	2.6	2.7	3.0	3.3	3.7	4.0
K/Q	4.0	4.0	4.0	4.0	4.0	4.0	3.9	3.7	3.6	3.5	3.3
Q/L^*	100.0	100.1	100.2	100.4	100.4	100.0	99.1	97.7	96.0	94.3	92.8
Q/N	100.0	99.6	98.4	96.0	92.3	88.0	84.2	81.1	78.9	77.1	75.9
S/Q	24.3	24.3	24.5	24.2	23.7	22.9	22.2	21.9	21.7	21.9	22.0
S'/Q	4.5	4.5	4.6	4.2	3.7	3.1	2.8	3.2	3.8	4.6	5.3

Note: The note to Table 1 applies to this table except that indexes are relative to base level 100.0 in 1936.

TABLE 7: COUNTERFACTUAL HISTORICAL SIMULATION: BABY BOOM FOLLOWED BY LESS PRONOUNCED FERTILITY DECLINE THAN IN ACTUAL BABY BUST (EXPERIMENT 14)

	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986
Life style variables											
(new cohort)											
C^*	100.0	97.9	93.5	89.2	98.6	107.2	105.4	103.2	101.9	102.6	104.6
R_1	100.0	97.5	92.8	87.8	97.2	108.1	111.7	117.0	121.5	123.9	122.7
R_2	100.0	97.6	93.1	88.4	97.8	107.8	109.0	110.8	112.7	114.3	114.7
F	3.1	3.3	3.9	4.5	3.2	2.2	2.1	2.1	2.1	2.1	2.1
Population and the macroeconomy											
TFR	2.8	3.0	3.2	3.6	3.9	3.6	2.9	2.4	2.2	2.1	2.1
B/N	20.5	21.3	22.9	25.3	26.4	24.0	19.9	17.6	17.8	18.3	17.7
$\%N_{0-14}$	27.5	27.8	28.5	29.9	31.8	32.9	32.0	29.1	26.2	24.8	24.7
$\%N_{65+}$	11.0	10.9	10.8	10.6	10.3	10.0	9.9	10.0	10.0	10.1	10.2
g(N)	1.1	1.2	1.4	1.7	1.8	1.6	1.2	0.9	0.9	1.0	0.9
g(L)	1.1	1.1	1.0	0.9	1.1	1.6	2.1	2.4	2.0	1.4	1.0
$g(L^*)$	1.1	1.1	1.0	1.0	1.1	1.4	1.8	2.1	2.0	1.7	1.3
g(Q)	1.1	1.1	1.1	1.0	1.0	1.2	1.5	1.8	1.9	1.7	1.5
g(K)	1.1	1.1	1.2	1.1	0.9	0.7	0.8	1.1	1.5	1.9	2.0
r	2.6	2.6	2.5	2.5	2.5	2.7	2.9	3.2	3.4	3.4	3.2
K/Q	4.0	4.0	4.0	4.0	4.0	3.9	3.8	3.7	3.6	3.6	3.6
Q/L^*	100.0	100.1	100.2	100.4	100.3	99.6	98.3	96.8	95.8	95.7	96.5
Q/N	100.0	99.6	98.4	96.0	92.6	90.0	90.2	93.2	97.7	101.8	105.1
S/Q	24.3	24.3	24.5	24.2	23.3	22.4	22.0	22.9	23.7	24.8	25.4
S'/Q	4.5	4.5	4.6	4.2	3.3	2.9	3.0	4.6	5.8	7.0	7.2

Note: The note to Table 1 applies to this table except that indexes are relative to base level 100.0 in 1936.

TABLE 8: FUTURE SCENARIO: PREFERENCES UNCHANGED (EXPERIMENT 15)

	1986	1991	1996	2001	2006	2011	2016	2021	2026	2031	2036
Life style variables											
(new cohort)											
C^*	100.0	102.8	105.1	107.4	110.6	114.6	118.7	121.8	123.9	125.9	127.7
R_1	100.0	96.1	90.9	85.8	81.3	77.3	73.8	70.5	68.3	67.5	68.0
R_2	100.0	98.9	96.7	94.4	92.5	91.1	89.9	88.4	87.2	87.1	87.9
F	1.7	1.7	1.7	1.8	1.8	1.9	1.9	2.0	2.0	2.1	2.1
Population and the macroeconomy											
TFR	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.9	2.0	2.0	2.0
B/N	14.7	13.4	12.2	11.6	11.6	11.6	11.4	11.1	11.1	11.4	11.8
$_{ZN_{0-14}}$	21.7	20.9	19.8	18.4	17.4	17.1	17.0	17.0	16.9	16.9	17.2
$_{ZN_{65+}}$	10.7	11.0	11.4	12.0	12.7	13.8	15.6	17.9	20.3	21.6	21.6
g(N)	0.6	0.4	0.3	0.2	0.1	0.0	-0.1	-0.2	-0.3	-0.4	-0.4
g(L)	0.9	0.5	0.4	0.1	-0.3	-0.6	-0.9	-1.1	-0.9	-0.6	-0.4
$g(L^*)$	1.2	0.9	0.6	0.2	-0.1	-0.5	-0.9	-1.1	-1.0	-0.6	-0.4
g(Q)	1.5	1.2	1.0	0.7	0.4	0.0	-0.4	-0.6	-0.7	-0.5	-0.4
g(K)	2.1	2.1	1.9	1.7	1.5	1.3	0.9	0.4	0.0	-0.3	-0.5
r	3.2	2.9	2.6	2.2	1.8	1.4	1.1	0.7	0.5	0.4	0.4
K/Q	3.6	3.8	3.9	4.1	4.4	4.7	5.0	5.3	5.5	5.6	5.6
Q/L^*	100.0	101.6	103.6	105.8	108.3	111.2	114.2	117.1	119.2	120.2	120.3
Q/N	100.0	104.2	108.0	111.3	113.3	113.7	112.6	110.4	108.0	106.7	106.4
S/Q	25.9	26.6	27.0	27.7	28.3	28.8	28.7	27.9	27.0	26.0	25.1
S'/Q	7.7	7.7	7.3	7.0	6.4	5.6	3.9	1.6	-0.4	-2.0	-2.9

Note: The note to Table 1 applies to this table except that indexes are relative to base level 100.0 in 1986.

TABLE 9: FUTURE SCENARIO: SMALL INCREASE IN PREFERENCE FOR CHILDREN (EXPERIMENT 16)

	1986	1991	1996	2001	2006	2011	2016	2021	2026	2031	2036
Life style variables											
(new cohort)											
c^*	100.0	102.8	103.9	105.1	108.2	112.1	115.8	117.9	119.1	120.2	121.3
R_1	100.0	96.1	89.9	83.9	79.3	75.4	71.9	68.6	66.3	65.7	66.6
R_2	100.0	98.9	95.7	92.3	90.4	89.0	87.6	85.8	84.3	84.1	85.1
F	1.7	1.7	1.9	2.0	2.1	2.1	2.2	2.3	2.3	2.3	2.3
Population and the macroeconomy											
TFR	1.7	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.2	2.3	2.3
B/N	14.7	13.4	12.3	12.1	12.6	12.9	12.7	12.5	12.7	13.3	13.9
$\%N_{0-14}$	21.7	20.9	19.8	18.6	17.9	18.0	18.5	18.7	18.7	18.9	19.5
$\%N_{65+}$	10.7	11.0	11.4	12.0	12.7	13.7	15.3	17.4	19.5	20.5	20.3
g(N)	0.6	0.4	0.3	0.2	0.2	0.2	0.1	0.0	-0.1	-0.1	-0.1
g(L)	0.9	0.5	0.4	0.1	-0.3	-0.7	-0.9	-0.9	-0.7	-0.3	-0.1
$g(L^*)$	1.2	0.9	0.6	0.2	-0.2	-0.5	-0.9	-1.0	-0.8	-0.4	-0.1
g(Q)	1.5	1.2	1.0	0.7	0.3	0.0	-0.4	-0.6	-0.6	-0.4	-0.2
g(K)	2.1	2.1	1.9	1.7	1.5	1.2	0.8	0.3	-0.1	-0.3	-0.5
r	3.2	2.9	2.6	2.2	1.8	1.4	1.0	0.7	0.5	0.5	0.5
K/Q	3.6	3.8	4.0	4.1	4.4	4.7	5.0	5.2	5.4	5.5	5.4
Q/L^*	100.0	101.6	103.6	105.8	108.4	111.3	114.2	116.8	118.6	119.1	118.7
Q/N	100.0	104.2	108.0	111.1	112.5	112.1	110.2	107.2	104.4	102.7	102.0
S/Q	25.9	26.6	27.1	27.7	28.4	28.7	28.4	27.4	26.3	25.3	24.4
S'/Q	7.7	7.7	7.3	7.0	6.4	5.4	3.6	1.2	-0.7	-2.1	-2.7

Note: The note to Table 1 applies to this table except that indexes are relative to base level 100.0 in 1986.

TABLE 10: FUTURE SCENARIO: MODERATE INCREASE IN PREFERENCE FOR CHILDREN (EXPERIMENT 17)

	1986	1991	1996	2001	2006	2011	2016	2021	2026	2031	2036
Life style variables											
(new cohort)											
C^*	100.0	102.8	101.0	99.0	102.0	105.7	108.4	108.6	108.1	107.8	107.6
R_1	100.0	96.1	87.3	78.8	74.4	70.6	67.1	63.8	61.9	62.3	64.4
R_2	100.0	98.9	92.9	86.8	84.9	83.6	81.9	79.5	77.9	78.0	79.4
F	1.7	1.7	2.2	2.7	2.8	2.9	2.9	3.0	3.0	3.0	3.0
Population and the macroeconomy											
TFR	1.7	1.7	1.8	2.0	2.4	2.6	2.8	2.9	3.0	3.0	3.0
B/N	14.7	13.4	12.5	13.3	15.2	16.3	16.3	16.1	17.0	18.6	19.8
$\%N_{0-14}$	21.7	20.9	19.9	18.9	19.1	20.5	22.1	23.0	23.4	24.1	25.4
$\%N_{65+}$	10.7	11.0	11.4	11.9	12.5	13.2	14.5	16.2	17.7	18.1	17.2
g(N)	0.6	0.4	0.3	0.3	0.5	0.5	0.5	0.4	0.4	0.6	0.7
g(L)	0.9	0.5	0.3	0.0	-0.4	-0.7	-0.8	-0.5	0.0	0.4	0.7
$g(L^*)$	1.2	0.9	0.5	0.2	-0.2	-0.6	-0.8	-0.8	-0.3	0.3	0.7
g(Q)	1.5	1.2	1.0	0.6	0.3	-0.1	-0.4	-0.5	-0.3	0.1	0.3
g(K)	2.1	2.1	1.9	1.7	1.5	1.2	0.7	0.1	-0.2	-0.4	-0.5
r	3.2	2.9	2.6	2.2	1.8	1.4	1.0	0.8	0.7	0.8	1.0
K/Q	3.6	3.8	4.0	4.2	4.4	4.7	5.0	5.2	5.2	5.2	5.0
Q/L^*	100.0	101.6	103.6	105.9	108.6	111.5	114.2	116.3	117.0	116.2	114.6
Q/N	100.0	104.2	108.0	110.5	110.6	108.1	103.9	99.3	95.4	92.7	90.9
S/Q	25.9	26.6	27.2	27.9	28.4	28.4	27.6	26.1	24.7	23.6	22.7
S'/Q	7.7	7.7	7.4	7.1	6.4	5.0	2.8	0.3	-1.5	-2.3	-2.3

Note: The note to Table 1 applies to this table except that indexes are relative to base level 100.0 in 1986.

TABLE 11: FUTURE SCENARIO: LARGE INCREASE IN PREFERENCE FOR CHILDREN (EXPERIMENT 18)

	1986	1991	1996	2001	2006	2011	2016	2021	2026	2031	2036
Life style variables											
(new cohort)											
C^*	100.0	102.8	98.2	93.4	96.3	99.7	101.6	100.7	99.2	98.1	96.9
R_1	100.0	96.1	84.9	74.1	69.8	66.2	62.8	59.6	58.5	59.9	63.3
R_2	100.0	98.9	90.3	81.8	79.9	78.6	76.7	74.0	72.7	73.4	75.4
F	1.7	1.7	2.5	3.4	3.5	3.6	3.7	3.8	3.7	3.7	3.6
Population and the macroeconomy											
TFR	1.7	1.7	1.8	2.2	2.8	3.3	3.5	3.6	3.7	3.7	3.7
B/N	14.7	13.4	12.8	14.5	17.7	19.6	19.6	19.6	21.2	23.8	25.4
$\%N_{0-14}$	21.7	20.9	19.9	19.3	20.3	22.9	25.5	26.9	27.5	28.7	30.7
$\%N_{65+}$	10.7	11.0	11.4	11.9	12.3	12.8	13.8	15.1	16.2	16.0	14.7
g(N)	0.6	0.4	0.3	0.5	0.7	0.9	0.9	0.8	1.0	1.2	1.4
g(L)	0.9	0.5	0.3	0.0	-0.5	-0.8	-0.7	-0.2	0.6	1.1	1.4
$g(L^*)$	1.2	0.9	0.5	0.1	-0.3	-0.7	-0.8	-0.5	0.1	0.8	1.3
g(Q)	1.5	1.2	1.0	0.6	0.2	-0.1	-0.4	-0.4	0.0	0.4	0.8
g(K)	2.1	2.1	1.9	1.8	1.5	1.1	0.5	0.0	-0.4	-0.5	-0.5
r	3.2	2.9	2.6	2.2	1.8	1.4	1.0	0.9	0.9	1.1	1.5
K/Q	3.6	3.8	4.0	4.2	4.4	4.7	5.0	5.1	5.1	4.9	4.6
Q/L^*	100.0	101.6	103.6	106.0	108.8	111.7	114.3	115.7	115.5	113.7	111.0
Q/N	100.0	104.2	107.9	110.0	108.7	104.2	98.2	92.3	87.4	83.8	81.0
S/Q	25.9	26.6	27.3	28.0	28.5	28.1	26.9	24.9	23.2	22.1	21.1
S'/Q	7.7	7.7	7.5	7.1	6.3	4.6	2.0	-0.6	-2.2	-2.4	-2.0

Note: The note to Table 1 applies to this table except that indexes are relative to base level 100.0 in 1986.

TABLE 12: FUTURE SCENARIO: SMALL DECREASE IN PREFERENCE FOR CHILDREN (EXPERIMENT 19)

	1986	1991	1996	2001	2006	2011	2016	2021	2026	2031	2036
Life style variables											
(new cohort)											
C^*	100.0	102.8	105.8	108.8	112.0	116.1	120.4	124.1	127.1	129.6	131.9
R_1	100.0	96.1	91.5	87.0	82.4	78.5	74.9	71.7	69.5	68.6	69.0
R_2	100.0	98.9	97.4	95.7	93.8	92.4	91.2	90.0	89.1	89.0	89.8
F	1.7	1.7	1.7	1.6	1.7	1.7	1.8	1.8	1.9	1.9	1.9
Population and the macroeconomy											
TFR	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.8	1.8	1.9
B/N	14.7	13.4	12.1	11.3	11.0	10.8	10.6	10.3	10.2	10.3	10.6
$\%N_{0-14}$	21.7	20.9	19.8	18.4	17.2	16.5	16.2	16.0	15.8	15.7	15.9
$\%N_{65+}$	10.7	11.0	11.4	12.0	12.8	13.9	15.7	18.2	20.7	22.2	22.5
g(N)	0.6	0.4	0.3	0.1	0.0	0.0	-0.2	-0.3	-0.4	-0.5	-0.6
g(L)	0.9	0.5	0.4	0.1	-0.2	-0.6	-1.0	-1.2	-1.1	-0.8	-0.6
$g(L^*)$	1.2	0.9	0.6	0.2	-0.1	-0.5	-0.9	-1.2	-1.1	-0.8	-0.6
g(Q)	1.5	1.2	1.0	0.7	0.4	0.0	-0.4	-0.7	-0.7	-0.6	-0.6
g(K)	2.1	2.1	1.9	1.7	1.5	1.3	0.9	0.5	0.0	-0.3	-0.5
r	3.2	2.9	2.6	2.2	1.9	1.5	1.1	0.7	0.4	0.3	0.3
K/Q	3.6	3.8	3.9	4.1	4.4	4.7	5.0	5.3	5.5	5.7	5.7
Q/L^*	100.0	101.6	103.6	105.8	108.3	111.1	114.2	117.2	119.5	120.9	121.3
Q/N	100.0	104.2	108.1	111.4	113.7	114.6	114.1	112.2	110.2	109.1	109.0
S/Q	25.9	26.6	27.0	27.7	28.3	28.9	28.9	28.2	27.3	26.4	25.5
S'/Q	7.7	7.7	7.3	6.9	6.4	5.6	4.1	1.9	-0.2	-1.9	-3.0

Note: The note to Table 1 applies to this table except that indexes are relative to base level 100.0 in 1986.

TABLE 13: FUTURE SCENARIO: GREATER DECREASE IN PREFERENCE FOR CHILDREN (EXPERIMENT 20)

	1986	1991	1996	2001	2006	2011	2016	2021	2026	2031	2036
Life style variables											
(new cohort)											
C^*	100.0	102.8	106.5	110.2	113.4	117.6	122.2	126.6	130.4	133.6	136.5
R_1	100.0	96.1	92.1	88.2	83.6	79.6	76.0	73.0	70.9	70.0	70.2
R_2	100.0	98.9	98.0	96.9	95.0	93.7	92.6	91.6	91.1	91.2	92.0
F	1.7	1.7	1.6	1.5	1.5	1.6	1.6	1.7	1.7	1.7	1.8
Population and the macroeconomy											
TFR	1.7	1.7	1.7	1.6	1.6	1.5	1.6	1.6	1.6	1.7	1.7
B/N	14.7	13.4	12.0	11.1	10.5	10.1	9.8	9.5	9.3	9.3	9.4
$\%N_{0-14}$	21.7	20.9	19.8	18.3	16.9	15.9	15.3	14.9	14.6	14.5	14.5
$\%N_{65+}$	10.7	11.0	11.4	12.0	12.8	14.0	15.9	18.5	21.2	22.8	23.3
g(N)	0.6	0.4	0.3	0.1	0.0	-0.1	-0.3	-0.4	-0.5	-0.7	-0.8
g(L)	0.9	0.5	0.4	0.1	-0.2	-0.6	-1.0	-1.2	-1.2	-1.0	-0.8
$g(L^*)$	1.2	0.9	0.6	0.3	-0.1	-0.5	-0.9	-1.2	-1.2	-1.0	-0.8
g(Q)	1.5	1.2	1.0	0.7	0.4	0.0	-0.4	-0.7	-0.8	-0.7	-0.7
g(K)	2.1	2.1	1.9	1.7	1.5	1.3	1.0	0.5	0.1	-0.3	-0.5
r	3.2	2.9	2.6	2.2	1.9	1.5	1.1	0.7	0.4	0.2	0.2
K/Q	3.6	3.8	3.9	4.1	4.4	4.6	5.0	5.3	5.6	5.7	5.8
Q/L^*	100.0	101.6	103.6	105.7	108.2	111.1	114.2	117.3	119.9	121.6	122.4
Q/N	100.0	104.2	108.1	111.5	114.1	115.5	115.5	114.2	112.4	111.5	111.6
S/Q	25.9	26.6	27.0	27.6	28.3	29.0	29.1	28.5	27.7	26.8	25.9
S'/Q	7.7	7.7	7.2	6.9	6.4	5.7	4.3	2.1	0.0	-1.9	-3.2

Note: The note to Table 1 applies to this table except that indexes are relative to base level 100.0 in 1986.